JUNE 1950

Journal

VOL. 42 • NO. 6

AMERICAN WATER WORKS ASSOCIATION

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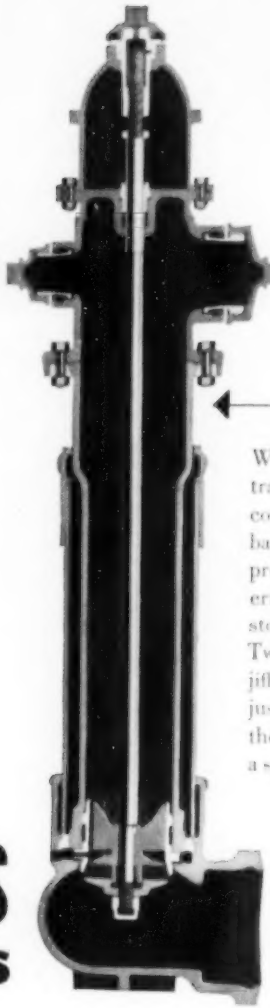
SPEED OF REPLACEMENT MEANS SAFETY FOR THE COMMUNITY



When a hydrant is broken in a traffic accident, it is a matter of community concern to get it back in operating condition promptly. The Mathews Modernized Hydrant can be restored in a matter of minutes! Two men can do the job, in a jiffy and *without excavating*, just as soon as they can get to the scene of the accident with a spare barrel and a lug wrench.

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Mathews Modernized Hydrants Set the Pace: Easily maintained because simple in construction • All working parts contained in the replaceable barrel • Stuffing box cast integral with nozzle section • Head can be turned 360° • Replaceable head • Nozzle sections easily changed • Nozzle levels raised or lowered without excavating • Protection case of "Sand-Spun" cast iron for extra strength, toughness, elasticity • Operating thread only part to be lubricated • A modern barrel makes an old Mathews good as new

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Whether your daily water consumption demands be 3,000,000 gallons or hundreds of times that figure, Lock Joint Pipe Company is prepared to provide the supply line you need.

In the last few years the Company has supplied not only hundreds of miles of large diameter pipe but also more than a million feet of 16" to 24" pipe for municipalities and industry. This has been made possible through the establishment of three permanent manufacturing plants. Lock Joint Concrete Pressure Pipe from 16" to 42" in diameter, produced at these plants, can be shipped economically to all parts of the country for major installations and minor extensions.

Our representative will be glad to discuss with you any water supply or transmission project which calls for pressure pipe 16" in diameter or larger. You will find that Lock Joint Concrete Pressure Pipe's superior characteristics of long life, continuous high flow and negligible upkeep will recommend it above all others for any permanent installation.

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Est. 1905

P.O. Box 269, East Orange, N. J.

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Threatened Water shortage

CAUSE – increased water consumption –

FROM 700 MGD TO 1200 MGD

REMEDY

UNIVERSAL METERING AT A COST OF $35,000*

SAVING $29,200 ANNUALLY exclusive of possible savings in sewage disposal

RESULTS:

1. DOMESTIC CONSUMPTION DOWN 60%
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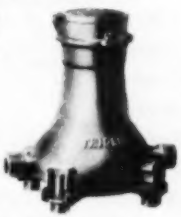
"It must not be taken for granted," writes a prominent Water Works General Superintendent and Chief Engineer, "that with the installation of meters all troubles come to an end. Meters must be properly maintained . . . Many a water company has became careless in meter maintenance, and as meter efficiency decreased, has looked to increased rates . . . A properly maintained meter department is the most important part of any water system." Trident Meters, simple, and rugged, with 100% interchangeability of parts, are easy and economical to maintain, at "new meter accuracy" through years of constant service.



***The cost of storage facilities at Naugatuck for equivalent additional water supply was estimated at MANY times the cost of metering ($35,000).**

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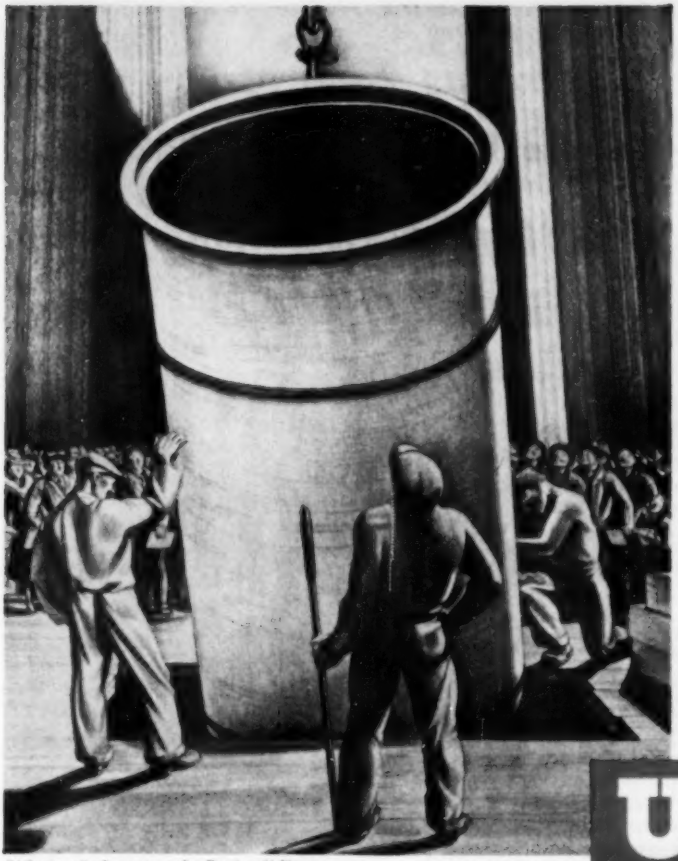

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Engineering Facts about

Johns-Manville TRANSITE* PRESSURE PIPE

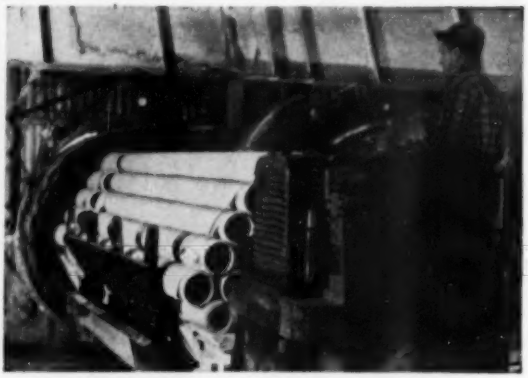
Resistance to Corrosion ...an index of long life

Ability to withstand corrosion is the most important single measure of the durability or life expectancy of an underground water pipe material. Two factors—both inherent in the pipe itself—contribute to Transite's exceptional ability to resist corrosion.

These are:

1. The inherently corrosion-resistant materials of which Transite is made.
2. The specially developed manufacturing process — employed exclusively by Johns-Manville—which imparts a high degree of chemical stability to the finished product.

In the manufacture of Transite Pipe, the three basic ingredients, asbestos fibres, cement, and silica—all basically corrosion-resistant by nature—are consolidated under tremendous pressure to form a pipe wall of dense, uniform, homogeneous structure. After forming, the pipe is subjected to a special steam curing process.



A load of Transite Pipe about to enter the steam curing tanks. This step in the Johns-Manville manufacturing process contributes substantially to the corrosion resistance of the finished pipe—and, therefore, to its long service life.

Transite Pipe was first used by this large west coast city in 1933. Its exceptional corrosion resistance—an index of long life—has already made it possible for Transite to outlive other pipe several times over.

*Transite is a registered Johns-Manville trade mark for its asbestos-cement pipe.

It is in this steam curing stage that so much is contributed to the stability and structural integrity of the pipe. Here under the action of pressure steam, Transite assumes a new chemical identity. The silica unites chemically with the free lime ordinarily associated with cement products and converts it into highly stable, insoluble calcium silicates. As a result, the cured pipe is unusually resistant to corrosive attack throughout its entire structure.

This intrinsic resistance to corrosion has been substantiated by numerous installa-

Transite Pipe was installed in this Texas city ten years ago to replace another pipe material that had been destroyed by soil corrosion in 7 years. The Transite mains are still on the job today with a long useful life ahead of them.

tions. Some of these have been exposed to highly aggressive soils, both alkaline and acid, for many years. Many are now serving as replacements for other types of pipe materials under conditions so destructive that their useful service life had been seriously curtailed.

Like thousands of other communities, this West Virginia city selected Transite Pipe because it promised assurance of maximum life. Today, after 14 years of service, the first installation of Transite has already fulfilled this promise by outlasting the pipe material previously used.

In one such installation, a Transite main installed during 1932 in an extremely corrosive soil was recently made the subject of careful study to determine its condition. Sections of the pipe, including couplings, were dug up and shipped to the factory for test. There was no evidence of deterioration. Pipe and couplings readily withstood the original factory test, equivalent to four times the normal working pressure of the line.

Certain types of industrial service provide an even more severe "proving ground" for the life expectancy of pipe materials, and here, too, Transite Pipe has demonstrated exceptional corrosion resistance. Coal mine service is a typical example. Here acid mine waters are frequently so corrosive that they have destroyed ordinary pipe materials in a matter of a few weeks or months. Yet Transite Pipe has handled these same waters under working pressure up to 150 lbs. for periods from 10 to 15 years with little, if any indication of deterioration.

To evaluate the ability of pipe materials to withstand soil corrosion, the National

Corrosive soil conditions were so severe at this location in a prominent New England city that the life of the pipe material formerly used was only 15 years. Transite Pipe, put in as a replacement in 1934, continues to give the same efficient, dependable service as the day it was installed.

Bureau of Standards has conducted an extensive series of field tests. These studies are based on examination of hundreds of pipe samples periodically removed from severely corrosive soils. In these and similar tests, Transite Pipe has consistently demonstrated its superior resistance to soil corrosion, confirming the long life expectancy which this asbestos-cement pipe has evidenced in thousands of water works installations.

Transite's ability to provide long-term, dependable service is well illustrated by its performance in coal mines, where it consistently outlasts other pipe materials in carrying corrosive mine drainage waters. The 36" Transite line shown above has been conveying acid mine waters for 15 years.

For further details about Transite Pressure Pipe, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE
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PRODUCTS

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7–8—New York Section at Saranac, N.Y.

13–14—West Virginia Section at Huntington, W.Va.

19–21—Wisconsin Section at Oshkosh, Wis.

27–29—Rocky Mountain Section at Santa Fe, N.M.

28–29—Ohio Section at Columbus, Ohio.

October **1–3**—Missouri Section at St. Louis, Mo.

11–13—Alabama-Mississippi Section at Mobile, Ala.

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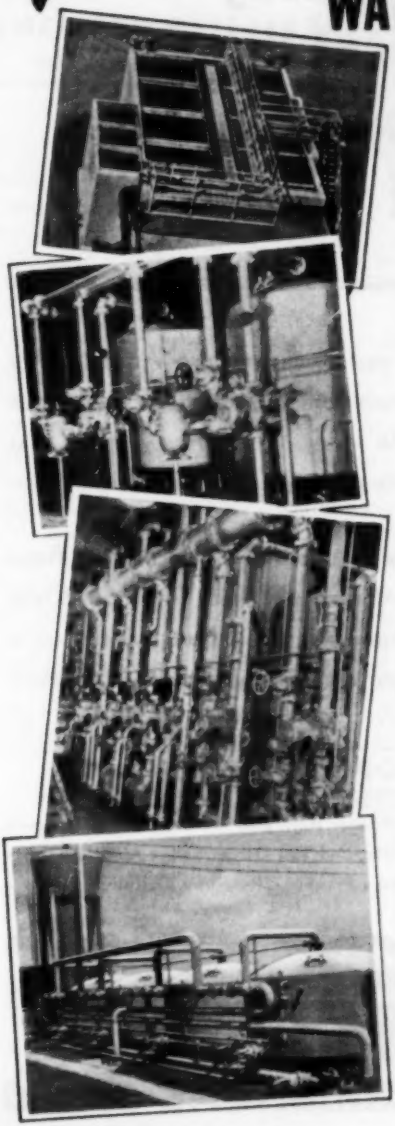

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Journal

AMERICAN WATER WORKS ASSOCIATION

Vol. 42 • No. 6

June 1950

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With
Break-Point Chlorination

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2. Entire elimation of presumptive gas forming and Coliform bacteria at the plant.
3. Reduction in the number of filters washed:
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5. A larger chloramine residual leaving the plant than we formerly were wont to carry.

At the present time we have not realized any savings in the cost of chemicals. This is primarily due to the type of water we must treat. Since the raw water has a low alkalinity the additional use of chlorine must of necessity call for soda ash treatment and therefore additional cost.

Regardless of the cost we feel that the efforts expended to install and maintain the Break-Point process of chlorination has been unquestionably justified.

Yours very truly,

CINCINNATI WATER WORKS

Supt'vr. of Water Purification

From: E. B. Beam

6-52

To find out how your plant can obtain all these advantages call your nearest W & T Representative today.

Exterior view, chlorinator house at the Cincinnati Filtration Plant.

Interior view showing Wallace & Tiernan Master Chlorinators, Type MARSV on the left, with their accompanying evaporators on the right.

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Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 42 • JUNE 1950 • NO. 6

Water Supply in Alaska

By Amos J. Alter

A contribution to the Journal by Amos J. Alter, Director, Div. of Sanitation & Eng., Territorial Dept. of Health, Juneau, Alaska.

THE water supplies of Alaska are largely from surface sources, although many wells and some springs are also used. Inadequate or unsafe supplies in many parts of the territory have retarded industrial development and caused illness. A better understanding of arctic and subarctic water supply needs promises a much brighter future.

Physiography and Population

Alaska, the largest peninsula on the North American continent, together with the Aleutian Archipelago, extends from 51 to 72 deg. North Latitude and from 130 deg. West to 172 deg. East Longitude. This is as great a span of latitude and longitude as is covered by the entire continental United States. The area of 586,000 square miles makes it about one-fifth the size of continental United States. Although the white man's conquest of this vast region—with its 27,000 miles of coastline, numerous mountain peaks more than 14,000 ft. in elevation, mountain ranges and broad valleys—started with Bering's visit in 1728, it still holds many secrets.

There are three distinct major regions in Alaska: the Pacific Mountain region, with its maritime climate on the seaward side; the Central Plateau region, which is relatively dry; and the Arctic Slope region, which is semiarid.

Precipitation ranges from an annual mean of less than 5 to over 200 in. Temperatures range from 100° to −71°F. Figures 1–3, based on U.S. Weather Bureau data, indicate the precipitation and temperatures which may be expected in different areas of Alaska.

In polar regions, the earth remains continuously frozen from a few feet to several hundred below the surface, with exception of a shallow layer which is seasonally thawed. This condition is called "permafrost." Underlying permafrost may be found in almost 60 per cent of Alaska. Figure 4 shows

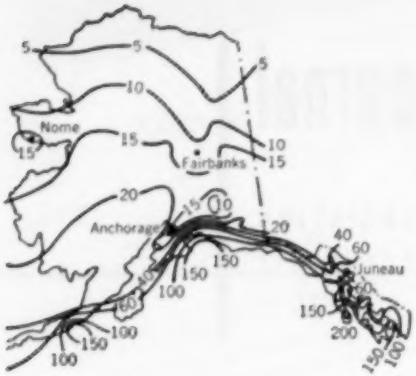

FIG. 1. Mean Annual Precipitation (in.)

FIG. 3. Minimum Recorded Temperatures (°F.)

approximate mean annual ground temperatures at a depth of 8 ft. in different regions.

Fisheries, mining, forestry, fur farming, the infant tourist industry and the usual service industries form the economic backbone of Alaska. Fish processing and mining require large amounts of water. Although almost 400 domestic and industrial water systems are in use at present, there are only 58 communities with a population of 200 or over. Anchorage is the largest community, with an estimated population of 20,000 (the total estimated population of Alaska was 92,000 in 1948). Domestic and industrial water supply demands range from a few gallons a day to 120 mgd. In the mountainous sections, large amounts of water are used for power purposes. Mining operations require water for "hydraulicking," and in some communities domestic consumption and waste have been found to run as high as 700 gpd. per capita.

Pacific Mountain Region

Water supply problems in the Pacific Mountain region do not differ materially from those of the continental United States. Practically all sources

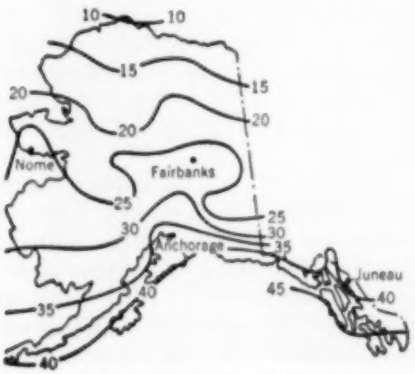

FIG. 2. Mean Annual Air Temperatures (°F.)

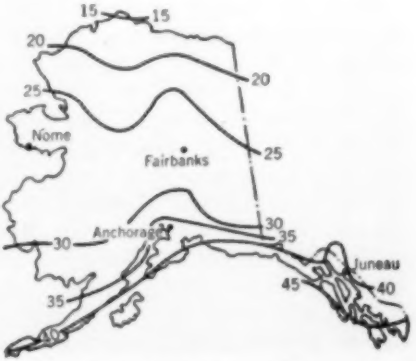

FIG. 4. Mean Annual Ground Temperatures (°F.)

in this area are mountain streams and lakes fed from rain and snow on the heavily wooded slopes of the coastal ranges. Spruce, hemlock and cedar trees, interspersed with "muskeg flats" and berry bushes, predominate on the watersheds in the southeastern and central coastal section. Relatively few trees are found on the watersheds in the remainder of the coastal region. Rapid sand filtration is applied in only three of the communities in this region, and less than one-fourth of the supplies receive chlorination. Heavy coliform bacteria contamination is general in these supplies during certain periods. Studies have indicated that each year approximately one person out of every four served from these supplies suffers from gastrointestinal disturbances at times when pronounced thaw or heavy rainfall occurs on the watersheds. It has rarely been possible to determine any of the specific etiological agents in these outbreaks, but they bear many of the characteristics of waterborne contamination.

Although surface sources are most common in this area, there are a few well supplies. The lack of forests on watersheds and the rugged mountain terrain make impounding reservoirs necessary for most supplies.

Very little is known concerning the ground water possibilities in any part of Alaska. Heavy precipitation throughout the Pacific Mountain region has tended to retard the investigation or development of ground water sources.

Central Plateau Region

Relatively little precipitation and severe cold weather during the winter months complicate the provision of adequate and continuous water supplies in the Central Plateau region. From November 1 to May 1 monthly mean temperatures are below freezing and surface water runoff is limited to that from springs. Streams with watersheds of less than 300–400 square miles do not have sufficient flow to maintain a free channel. Ice gradually thickens in such streams until it extends to the bed of the stream. Some runoff finds its way through the thawed gravels beneath the channel and a portion of the runoff may rise to the surface, spread and freeze rapidly. This frequently results in the formation of large bodies of ice commonly called

FIG. 5. Permafrost Area

"winter glaciers," which may reach 20 ft. in thickness and extend over wide areas where subchannel gravels are shallow and reefs of bedrock constrict the path of flow. The occasional existence of deep and relatively warm springs alters what may be called the normal cycle of surface water supply in this region.

Industrial as well as domestic water supplies from surface sources are usually seasonal. The quantity of water which is commonly available is the daily flow at the point of diversion.

In a few localities, surface and subsurface impounding of water has provided a continuous supply of water throughout the year. Most streams in the Central Plateau region are very flashy, because of frozen soil, steep slopes and lack of natural storage. Discharge measurements made by the U.S. Geological Survey on the Yukon River indicate that the runoff exceeds 60 per cent of the precipitation. Ellsworth and Davenport have stated: "The runoff per square mile from the drainage area of the Yukon above Eagle exceeds that of half the area of the United States" (1). Most water supplies in and near Fairbanks, a town of approximately 8,000 population, are relatively shallow wells.

Permanently frozen ground exists throughout most of Central Plateau region, as shown in Fig. 5. The problems of providing adequate and continuous ground water supplies in such areas are discussed below. Melted ice and snow are used for domestic water supply in many parts of this region.

Arctic Slope Region

The Arctic Slope region is a flat, treeless area which is very sparsely populated and at present has little industry. It is semiarid and tempered by the Arctic Ocean to a somewhat even but continuously low temperature.

Although there are myriads of shallow ponds and lakes and the relatively swampy tundra may be a veritable watery mass during the warm months, the long winter period keeps almost all such water sources in a frozen state. With present methods, it is not economically feasible for large communities or industries, under ordinary circumstances, to utilize much of the vast amount of water that is present practically everywhere in the arctic in the frozen state. The problem of obtaining an adequate water supply is really one of locating a continuous and readily usable source.

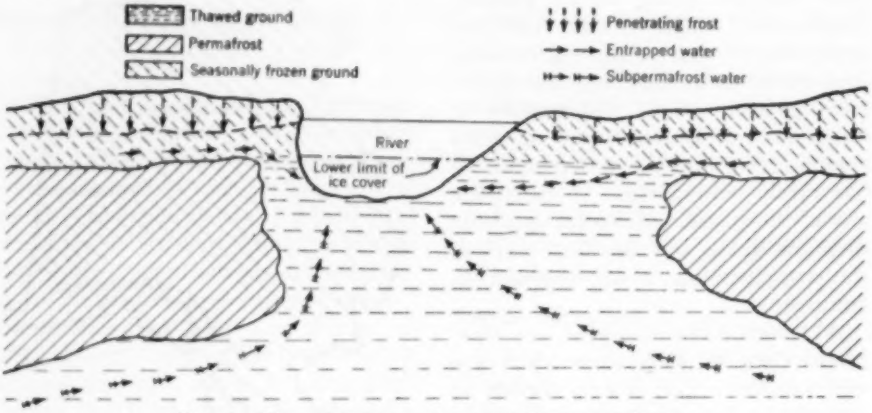

FIG. 6. Flow of Subpermafrost and Entrapped Water

In the arctic, shallow rivers, and sometimes deep ones, are frozen in the winter down to the bottom. Ground waters are found in smaller amounts than under temperate conditions. The usual water treatment practices must be modified to conform with low-temperature conditions. Where year-round distribution by pipes is provided, such a system often must be laid in permafrost. Water works buildings

and other structures may be damaged by the freezing and thawing of the ground under their foundations. Water must be preheated before it is introduced into the mains, or heated conduits must be used to protect the distribution system from damage by freezing.

In somewhat primitive arctic villages and towns, where water for domestic usage is obtained during most of the year by melting ice and snow, the average per capita consumption probably does not exceed 2 gpd. The cost of 100 gal. of water brought as ice from a distance of 2–25 miles is about $7.25, according to estimates made in 1947 for the village of Barrow, Alaska. Although this method is the principal way of obtaining water in the Arctic Slope region, it is not economically feasible for community and industrial water supply development.

Ice is cut from fresh-water lakes in the fall, when it is about 10–12 in. thick, and is stored either in permafrost cellars or on the surface of the ground in a convenient spot. As freezing may not exclude all impurities and pathogenic bacteria present in the water, ice cut from such a supply may be unsafe for human consumption. Pathogenic bacteria have been known to survive for a great period of time under freezing conditions. For household use, the harvested ice is taken a block at a time and placed in a container in a heated room, where it is allowed to melt. In the coastal areas of the Arctic Slope region, fresh-water ice is sometimes found on the salt-water ice of the ocean and used for human consumption.

Occasionally melted snow is employed as a source of water supply. The quantity of snow in many places is relatively small except where it has formed drifts. Barricades may be placed in such a fashion as to cause the drifting and accumulation of snow, but there is usually a great amount of dirt, silt and organic material mixed in with it.

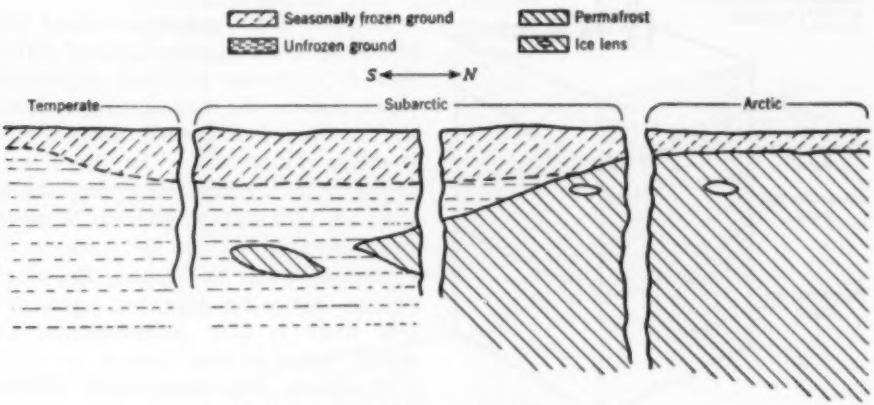

FIG. 7. Typical Occurrence of Permafrost

Present equipment used by civilians for melting snow and ice in the arctic is generally of an improvised nature. Steam generators and jets, for thawing frozen ground or holes in ice, are not economical for providing a community or industrial water supply and are impractical for use by small consumers. During the summer months water for

the household is generally obtained from fresh-water lakes or rivers. The water is dipped from the river or lake, poured into a barrel and hauled to the home.

Rainfall is so scanty throughout much of the Arctic Slope region that it is impractical to rely upon cisterns as a source of water supply. Even where sufficient rainfall and catchment area are available a cistern supply is economically unsatisfactory for more than two or three persons.

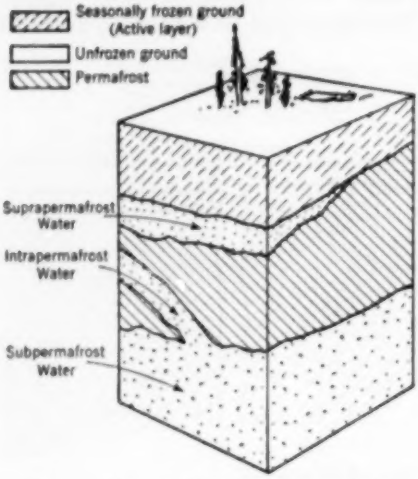

FIG. 8. Ground Water in Permafrost

Shallow surface sources are not practical where a continuous supply of water is needed, since they freeze and are unsatisfactory without treatment. Although seasonal ice rarely, if ever, exceeds a depth of 6–8 ft. on surface waters, the majority of these sources are only a few feet deep.

There are comparatively few rivers which are large enough to maintain an appreciable flow throughout the year. The utilization of water from rivers in the permafrost region is complicated not only by their tendency to freeze solid in some places, but also by the formation of frazil and anchor ice. The clogging of intakes by such formations has been controlled with steam lines placed in intake works.

Rivers receiving water from subpermafrost sources and entrapped water from extensive areas may flow continuously at points where the depth of channel and the quantity of flow are sufficient to offset tendencies to freeze (Fig. 6). Checks can be made on the temperature and general physical and chemical characteristics of water in a watercourse at intervals in order to locate appreciable subpermafrost supplies flowing into it.

In some areas, subsurface dams are placed across the path of ground water flow in a stream bed and perforated pipes laid in the bed upstream from the dam to collect ground water before it enters the stream. The latent heat of fusion from entrapped ground water may be sufficient to prevent a river from freezing, but, if the quantity of entrapped water is limited, the river source cannot be depended upon unless there is also subpermafrost or spring water flowing into it.

Relatively deep lakes, which do not freeze to the bottom, usually receive a considerable amount of entrapped water and frequently subpermafrost or artesian water. They serve as a continuous source of supply. Shallow lakes receiving enough entrapped water can be used as a limited supply source. The great proportion of ice to unfrozen water in a pond or lake which is not fed with entrapped water or from subpermafrost sources may make the quantity of stored water under the ice insufficient for supplying the demand over an extended period.

Arctic Ground Water

Figures 7 and 8 show the physical conditions surrounding ground water

supplies in northern Alaska. Suprapermafrost water (ground water above the permafrost layer) is irregular and quite often such sources disappear altogether before the end of winter, particularly in areas where the seasonal frost extends down to the permafrost. In the subarctic and southern sections of the permafrost region, shallow layers of thawed ground may exist continuously above the permafrost, and, in the presence of appropriate soil types, these layers serve as an aquifer for suprapermafrost water supplies. Such cilities are usually placed at about this same depth to avoid seasonal frost and yet not be in permafrost. Heat losses from houses tend to thaw the permafrost under them and cause the formation of a sumplike depression in the top of the permafrost.

Entrapped or artesian water found within the permafrost is called intrapermafrost water (Fig. 8). Such supplies are rare except in the southern portion of the area of permanently frozen ground. In the foothills of mountain ranges, where geological

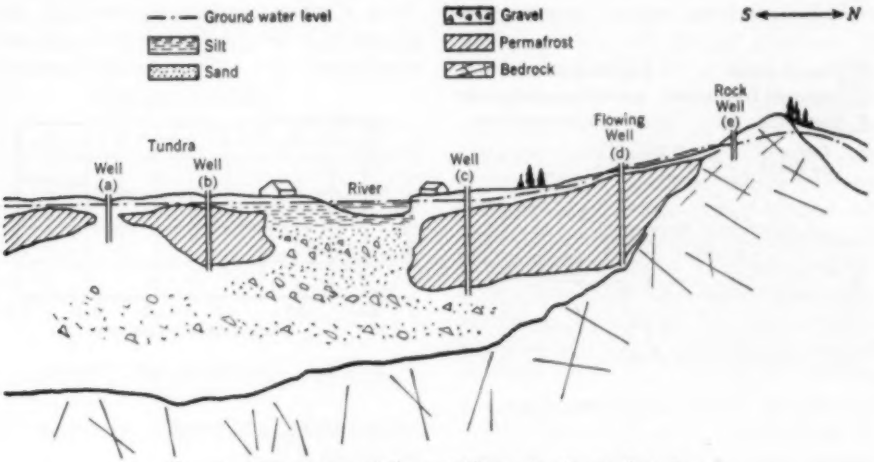

FIG. 9. Occurrence of Ground Water in Alaska Interior

supplies are generally poor producers, however, and cannot be depended upon if any great amount of water is needed. Several hundred such supplies are being used in interior Alaska. Ground water from above the permafrost is obtained by the use of bored, dug and driven wells or infiltration galleries.

The safety of the suprapermafrost supply is highly questionable for several reasons. It is rarely more than 10–20 ft. deep and receives water from the contaminated zone of the subsoil. Cesspools and other waste disposal formations and permafrost exist in such a fashion that subpermafrost water may be forced up into the permafrost by hydrostatic pressure, it is possible that such water may be found in fault zones of the permafrost (Fig. 8). The water is not in a stable position, however, and in time a supply of this type may be exhausted or may come through the permafrost and appear as suprapermafrost or subpermafrost water. Intrapermafrost water supplies may be tapped by the use of drilled or thawed and jetted wells. Like ground

water supplies in fissured limestone, intrapermafrost waters differ greatly in quality and safety.

Various types of well water supplies in use at Fairbanks, Alaska, are shown in Fig. 9. It may be noted that a thawed area exists on the inside of the river curve. Well (a) is a normal well. Wells (b) and (c) penetrate through the permafrost. Well (d) displays some artesian effect as a result of the confining layer of permafrost. Well (e) is a rock well. The zone between wells (d) and (e) is a probable site for frost mound formation (Fig. 10).

Subpermafrost water sources, al-

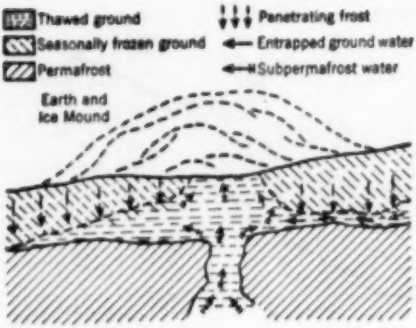

FIG. 10. Frost Mound Formation

though they may appear to be the most promising means of continuous arctic water supply, are difficult to locate, costly to develop and may be highly mineralized. Permafrost has been reported to extend to a depth of 900 ft. at some points in the arctic and pervious strata below this point are not readily charged with ground water. Moreover, where, as often happens, the permafrost extends to and into impervious strata such as rock, ground water is not available in appreciable quantities. Several satisfactory subpermafrost test wells have been drilled at Fairbanks. The warmest water may be found some distance below the lower limit of permafrost.

Well drilling through permafrost presents special problems and is relatively expensive. Wells penetrating permafrost must be operated almost continuously and sometimes heated to prevent freezing. Excessive pumpage may freeze a well or possibly change local hydrology. Note must also be taken of the effect of temperature on percolation. Movement of ground water through a water-bearing stratum is slower at a low temperature than at average temperatures, and the yield from a given type of aquifer may be appreciably less under low-temperature conditions (2). The relation between

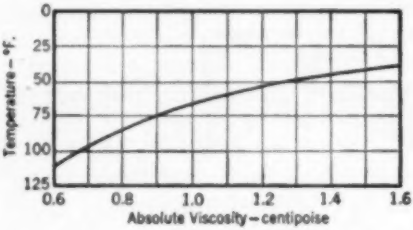

FIG. 11. Temperature and Viscosity

temperature and water viscosity is shown in Fig. 11.

Well casings must be adequately anchored in permafrost and constructed so that seasonal freezing of the surrounding soil does not disjoint, crush or otherwise destroy the casing.

It has been recommended that fill-around casings be of sand or gravel, to minimize cohesion of the seasonally frozen soil around the casing. Puddled clay may freeze to the casing and damage it. This type of construction enhances the possibility of contamination of the well by surface drainage. Wells should be located in a heated structure to avoid damage from seasonal frost and cold air. The wells

should not be placed in pits, however, because such an arrangement may disturb the thermal regime of the ground excessively, as well as increasing the possibility of contamination. A large-diameter casing and continuous moderate pumping are helpful in preventing the freezing of a well through permafrost since they reduce the tendency toward supercooling of the water and frazil ice formation.

Dynamiting subpermafrost and intrapermafrost wells in order to increase yield is a dangerous practice and, as in limestone wells, may result in contamination hazards.

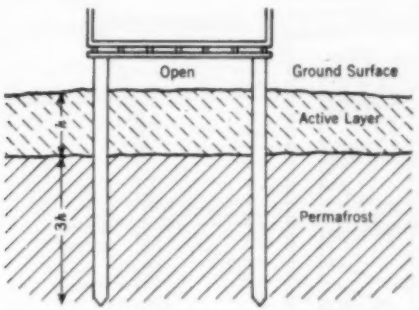

FIG. 12. Anchoring Piling in Permafrost

The records of the Alaska Dept. of Health show the occurrence of waterborne typhoid fever at several points in the permafrost region and also indicate the occurrence of reportedly waterborne dysentery in several arctic communities. Scores of shallow ground water supplies in the permafrost region have been found bacteriologically unsatisfactory. In addition, some waters are very hard.

As in temperate climates, arctic water supplies must be properly treated to render them physically and bacteriologically satisfactory. Although the principles involved appear to be the same in the arctic as elsewhere, the physical features of water treatment under low-temperature conditions may differ slightly at several points.

Protection of Facilities

Proper housing and insulation must be provided for all equipment and installations. Due regard must be taken for the protection of all units from the destructive forces of seasonal frost. The effect of permafrost must be evaluated before pumping stations, treatment facilities and water towers are constructed.

Air temperatures, the depth to which the ground thaws seasonally and the temperature of the permafrost govern construction methods and practice. If foundations do not extend into the permafrost, frost action in the thawed or active layer will cause settling and heaving of the structure. Damage may occur because parts of the permafrost and upper soil are removed and replaced with materials such as concrete which have a higher heat conductivity than the original soil. Heat within the structure, as well as heat absorbed by it from the sun's rays, is conducted through the foundation and into the ground, tending to destroy the permafrost. Thawing of the permafrost affects the stability of the soil, causing the structure to settle. Because of differential thawing and possible variations in soil characteristics, the structure may settle unevenly.

Water may drain down along the foundation and collect at the base of it. Refreezing of the soil and water causes heaving. An impervious layer of permafrost near the base of the foundation prevents the escape of entrapped water, and thus the effects of frost action are magnified. The effect on smaller buildings may be observed in almost any community in the Alaska permafrost zone. Annually repeated displacement of foundations, walls and other parts

of a structure causes leaks in reservoirs and cracks in walls, breaks foundations and threatens the stability of a structure.

Methods for preventing the thawing of permafrost and for anchoring structures into permafrost to forestall settling and heaving (Fig. 12) have been used to minimize frost effects. If the permafrost lies at a considerable depth, thawing is avoided by making a shallow excavation, a layer of ground 10–13 ft. thick being left between the bottom of the foundation and the upper level of permafrost. Excavation for the foundation is extended down 6 or 7 ft. Excavated ground is replaced with dry sand, gravel or rubble. Insulating layers, made of asphalt, felt impregnated with tar, or similar materials with a low heat conductivity, are recommended for foundations. Pilings are commonly used for foundations in many places in Alaska, and an 18–24-in. clear, open space is often left under buildings to prevent disturbance of the permafrost beneath the structure.

In the subarctic, where permafrost exists at a temperature near the freezing point, the upper permafrost may be completely thawed prior to placement of a structure. In such areas, the permafrost does not return and construction of stable facilities may thus be simplified.

The thawing of the ground under pumphouse floors must be prevented.

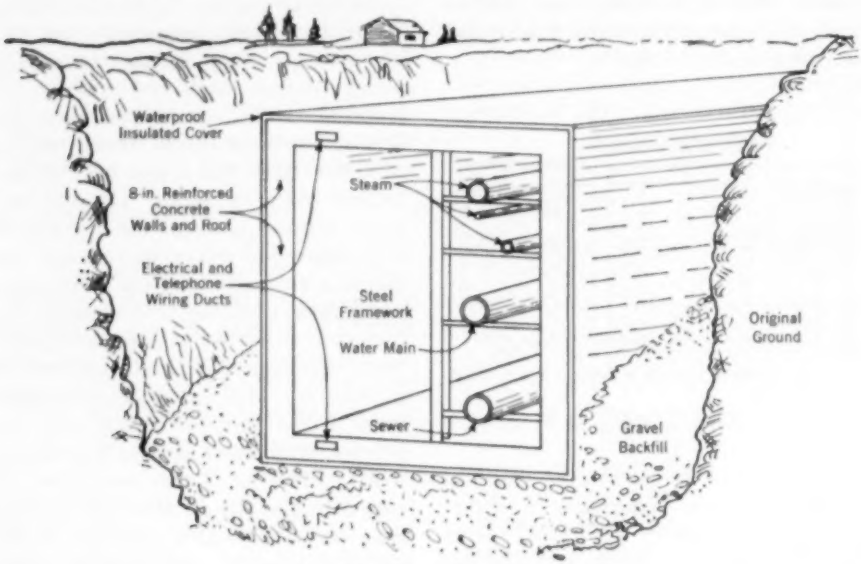

FIG. 13. Walk-Through Type Utilidor

Pipes passing through a pumphouse floor and under buildings must be properly insulated to prevent frost destruction. Pipes placed under continuous foundations may damage them if not properly insulated.

Foundations and walls should have a smooth finish, which decreases the cohesion of frozen ground with the wall and tends to prevent the raising of foundations. It is also desirable to give foundations a trapezoidal profile.

The surrounding excavation should be filled with coarse sand or gravel, and water should be led off by means of a drain. Clay or asphalt berms may be necessary to lead off surface water.

Unequal expansion and contraction of dissimilar materials used in equipment may result in damage to the unit. All piping must be installed with steep slope so that rapid drainage may be attained, and all drain ports must be large enough for this purpose. Water-lubricated equipment is subject to heated with a recirculating heater system.

Appropriate provision must be made for the use of heated outside air for the ventilation of enclosures where exposed water surfaces or other vapor sources may exist and tend to cause excessive condensation of moisture on the cold surfaces of the enclosing structure. Vapor barriers must be provided over all insulating walls in such enclosures to prevent insulating materials from being soaked and damaged by excessive condensation.

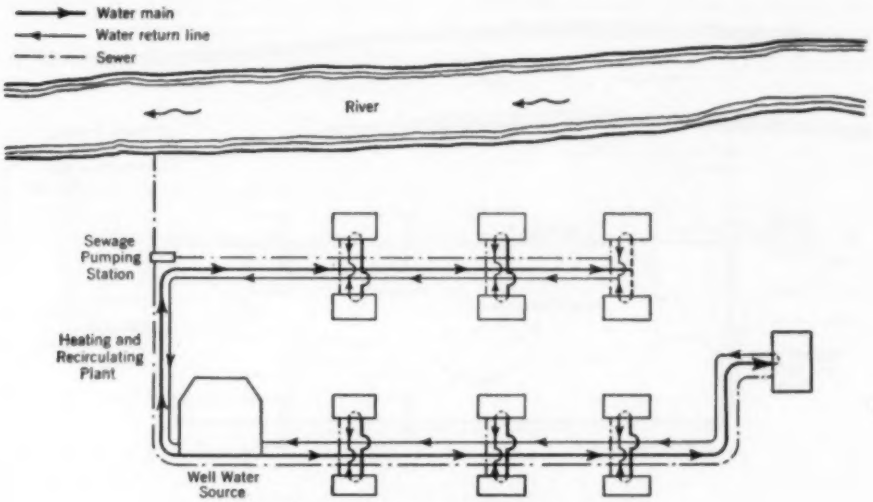

FIG. 14. Dual Main Recirculating System

rapid freezing immediately upon stopping unless heated, and, therefore, may sometimes be considered unsatisfactory for arctic use. Pumps, even though they are not water lubricated, may freeze when stopped. Drainage may leave enough moisture in a centrifugal pump to permit the impeller blades to freeze to the housing. An unheated or improperly protected filter may freeze in a few minutes when it is taken out of service. Elevated storage must be properly insulated and

Water treatment plants in the Central Plateau and Arctic Slope regions should be protected against low temperatures. Chemical mixing, filtration, settling and miscellaneous processes should be carried on in heated or insulated structures.

Chemicals used in water treatment generally do not mix or react as rapidly in cold water as in warm. Chlorine, which is commonly used for disinfecting water, is not so effective at low as at normal temperatures. In-

creased viscosity in water at low temperature causes a slower settling out of undesirable particles. Low temperatures also result in increased head losses in filters.

Distribution System Problems

Where community water distribution systems are used, tank trucks and large bottles are the most common means of distribution. The hoses, tank trucks, large bottles, corks and pails are easily contaminated and difficult to keep clean. be constructed of metal, concrete or wood and may be buried near the surface or placed above the ground. Some utilidors are large enough to allow workmen to walk through them to carry on regular maintenance (Fig. 13), while others merely permit passage of the service lines. Both water and sewer lines are frequently placed in the same utilidor, an arrangement which may become extremely hazardous because leaking sewers can contaminate the water supply. Great care

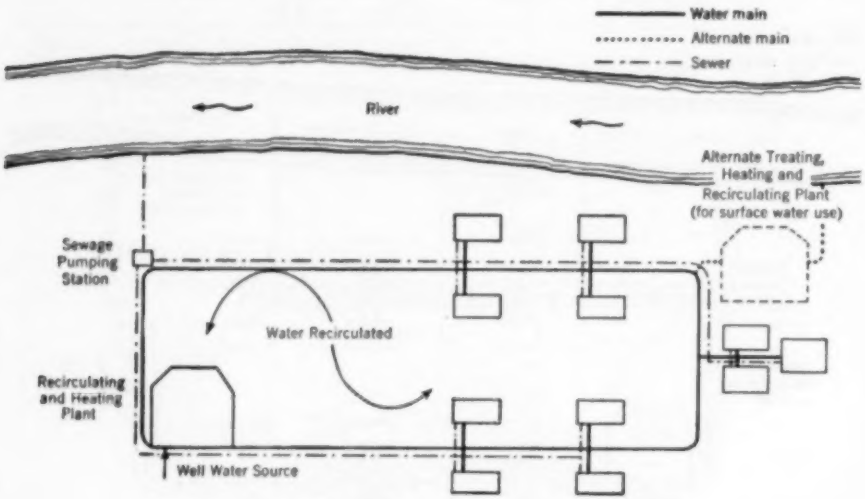

FIG. 15. Single-Main Recirculating System

In some communities, water is distributed during the warm months through temporary pipelines laid on the surface of the ground. These lines are disjointed and drained at the end of each summer, and the water is distributed by tank truck during the winter. Because practically no water is available for fire protection during much of the year, insurance rates are high.

In other areas, water is distributed by placing the pipelines in heated conduits called "utilidors." These may must be taken to provide proper drainage in utilidors to prevent the occurrence of this condition. If the utilidor is improperly sealed, entrapped ground water may enter and flood it. Without proper construction methods, waste heat from the utilidor may thaw the permafrost and also disturb the stability of the soil around the utilidor, resulting in much damage to the system.

In some settlements water is distributed by a recirculating system. The water is heated and pumped into the distribution system; water which is

not used is pumped back to the starting point again for additional heating and recirculation. The recirculating distribution system is sometimes constructed with two lines—a service and return line (Fig. 14). Figure 15 illustrates an arrangement for a single-main recirculating water distribution system.

The water in service lines extending from street main to house must also be recirculated or heated either from the house heating system or from the utilidor. Figure 16 illustrates a service connection for a dual-main recirculating system. An electrical heating unit may be used to protect house service lines from freezing. Such an arrangement

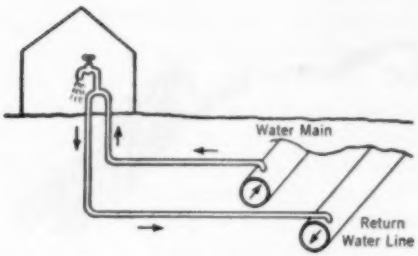

FIG. 16. Dual-Main Service Connection

is shown in Fig. 17, with the heating element a nickel-chromium wire and the current controlled by an air thermostat. In frozen ground, the cable extends to the main. Another method of protecting the service line is to enclose it in an extension of the utilidor carrying the main. Prefabricated utilidor units may be purchased from various supply houses. Shavings, peat, moss, gravel and other insulating materials are also used to protect the water distribution system from freezing.

Construction Costs

Construction costs in different sections of Alaska are affected chiefly by such factors as the accessibility of the area to regular shipping routes; local labor costs; local availability and demand for materials and construction equipment; and, in the Arctic Slope and Central Plateau regions, the need for modification of standard construction procedures because of low-temperature conditions.

In 1949 representatives of various government agencies in Alaska indicated that construction costs there were considerably higher than in continental United States. The relationship of construction costs in Alaska to costs in continental United States is shown in Fig. 18, the *Engineering News-Record* index for continental United States be-

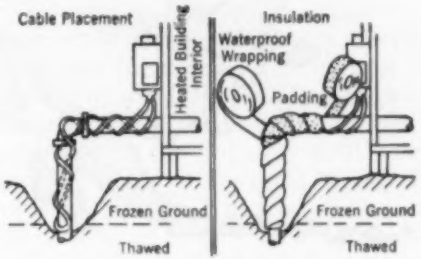

FIG. 17. Protection of Service Pipe

ing taken as 1. The Alaska costs are based on the opinions of the above-mentioned officials.

Summary

There is little reason to believe that the principles involved in domestic and industrial water supply in Alaska differ materially from those in temperate climates. But the application of these principles in the Central Plateau and Arctic Slope regions of Alaska is different. Satisfactory water supplies are difficult to obtain. Many surface supplies freeze, and much of the ground water is in a frozen state. With intelligent, systematic search, suitable supplies may be found, however. The

high viscosity of water at low temperatures has an appreciable effect on certain treatment practices, and design and operation must be adjusted accordingly.

Much research and investigative work are indicated in the application of the basic principles of water supply construction and operation in low-temperature areas.

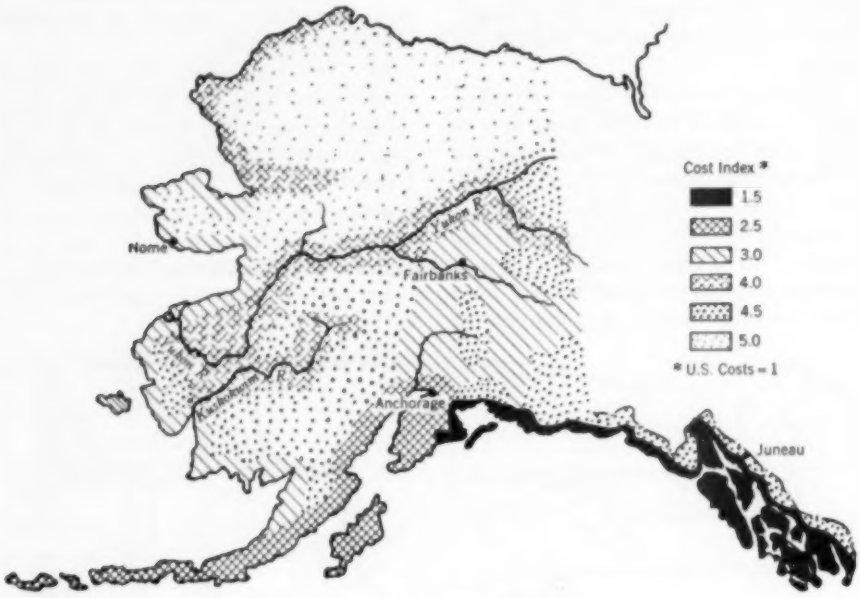

FIG. 18. Alaska Construction Costs

Special provision must be made for the distribution of water in regions where portions of the ground remain continuously frozen. Water may be heated and circulated in the distribution system, or it may be distributed from mains placed in heated conduits.

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Atomic Wastes and Water Quality

By W. A. Rodger

A paper presented on April 13, 1950, at the Illinois Section Meeting, Chicago, by W. A. Rodger, Asst. to Director, Chem. Eng. Div., Argonne National Lab., Chicago.

IN preparing this paper, the author was asked to reply to four questions: [1] What radiation level is considered safe for potable water? [2] What equipment is necessary to monitor a water supply in order not to exceed this level? [3] What is the effect of present water purification methods on radiation which may exist in the water? [4] What could a water works operator do if a sneak atomic bomb attack should raise the radiation level of the water above the tolerance point?

Unfortunately, no clearcut, unqualified answer can be given to any of these questions. An attempt will be made, however, to reply as fully as possible. In addition, some information will be given on the measures taken at U.S. Atomic Energy Commission installations to treat radioactive wastes produced in their operations.

The AEC has been in the uncomfortable position of both producing and policing its own radioactive wastes. It is to be hoped that, sometime in the near future, the policing will be guided by sensible, nationally accepted codes.

The mention of policing leads naturally into the problems of tolerances and monitoring. No absolute tolerance level can be fixed for radiation in water which will apply to all of the many different forms of radiation that may exist. Not only is there a vast difference in the physiological effects of the three basic types of radiation—alpha and beta particles and gamma rays—but each type has various energy levels and half-lives. Furthermore, each form may be associated with different chemical elements or compounds which will markedly affect the behavior of the radiation if introduced into a living organism.

Taking into account the various factors enumerated, permissible levels have been tentatively determined for a number of specific radioactive isotopes. A table of such data has recently been published in the JOURNAL (1). To give some idea of the great degree of variation possible, it may be noted that the permissible concentration, in microcuries per liter, is 0.0000001 for radium and 6,000 for radiocarbon (C 14), a variation of 10^{10}. Without the expenditure of astronomical sums of money, it will not be possible, in monitoring effluents, to make complete analyses for all known radioisotopes. They are too numerous and most of the determinations are very difficult. Hence, unless a given plant or area produces only a few specific types of radioactive material, some general permissible level will have to be adopted as a compromise. Such a figure will probably be set by the National Committee on Radiation Protection.

Another complication is the natural radioactivity, or natural radioactive background, of the water supply source. In general, this background amounts to

approximately 10^{-5} or 10^{-6} microcuries per liter, but a few mineral spring waters run as much as 10^{5} higher. If the supply source involved has a high natural background, it may be asked why the radioactive plant effluent should be maintained well below the natural level. Unless this is done, however, the discharge might be considerably above any nationally adopted standard. Furthermore, downstream monitoring, while not impossible, would become most difficult.

As yet no general tolerance level has been adopted, but it will probably be set at a concentration a shade above the normal natural background, with special provision for areas where the background is unusually high or low. The words "shade above" are used deliberately, and the author will make no attempt to define the phrase. No specific figure will be mentioned, because such statements, however well qualified, may tend to be accepted as fact prematurely. A great many people, including members of the water works profession, must be satisfied before a tolerance level can be established. (The above-mentioned National Committee on Radiation Protection has recently suggested that a figure of 10^{-4} microcuries per liter be used as a tentative level for guidance until further information is available.)

The ideal objective of the AEC is to discharge to nature no radioactive atom produced in its installations. This aim is a practical impossibility, although it might be realized if it were limited to *detectable* atoms. Even then, the operation would be fantastically expensive. Consequently, it is important to determine what level of activity may be discharged without harming any life in the area, and a great deal of effort is being devoted toward that end. When a tolerance level is adopted, it will presumably be changed from time to time as more knowledge is gained. The probability is that it will be made more generous rather than more stringent, since, whenever a reasonable doubt has existed, the AEC has tried to follow the safer, though admittedly more expensive, course.

Monitoring of Supplies

Devices for the continuous monitoring of water supplies at the low radioactivity levels involved are not commercially available, although the AEC is making a serious attempt to develop them. It is possible, but not easy, however, to assay liquids at these levels. A good representative sample must be carefully concentrated to a degree dictated by the solid content of the water. The final step requires plating a measured quantity of the concentrated liquid on a metal disk about the size of a quarter. If an alpha count is desired, the ideal results will be obtained only when a monomolecular layer of solids exists on the plate. In beta counting, a total of 20 mg. of solids will still give good results, and, for gammas, this factor is not so important.

The entire evaporation and plating process must be carried out under aseptic conditions. At low levels, the slightest contamination picked up during sample preparation will make the results meaningless. When prepared, the sample is mounted on a holder peculiar to the counter being used and is placed in a shielded counting chamber.

There are many different instruments available commercially which will count these samples, but none is yet completely satisfactory, although rapid strides are being made in achieving dependability. Counting is a statistical problem. As such, any absolute

number of counts is associated with a particular percentage error. The larger the number of counts, the lower the error. In low-level counting, the number of disintegrations per unit time is low, and the count must be taken over many hours to obtain any degree of accuracy. Moreover, all of these counters have a natural background or blank count, which must be determined often, as it changes a little from time to time. For most counters, the background count is large compared with the sample count being determined. This fact again introduces an error and requires very long counts, preferably with intermittent determination of background.

The counters themselves can hardly be classed with appliances like a vacuum cleaner which need merely be plugged into a wall socket and turned on. They are delicate electronic circuits and require regulated voltage, controlled temperature and humidity, and freedom from mechanical shock and even from loud noise. They must be rigidly protected from contamination and demand close attention.

Working with radioactivity at reasonable tracer levels is relatively easy, and many of the precautions discussed are not necessary. But determinations at levels approaching the natural background are another matter. It is not enough to buy one of the water plant employees a "Little Wizard Atomic Energy Set." Even with the best equipment obtainable, at least one well trained technician should be hired. For supervisors who will be responsible for such work, although perhaps not actually engaged in the manipulations, a one-month course is offered by the Oak Ridge Institute of Nuclear Studies.*

* Those interested should apply for information to Dr. Ralph T. Overman, Institute of Nuclear Studies, Oak Ridge, Tenn.

Effect of Ordinary Treatment

The effect of ordinary water purification methods on radiation present in the water constitutes another question to which only a preliminary answer can be given. A few very incomplete experiments indicate that 80–90 per cent of most forms of radioactivity would be removed. No data are available on whether a repeated treatment on mixed types of radioactivity would remove an additional 80 per cent or not.

Effects of Atomic Bombing

It is hard to see how an atom bomb attack could result in enough radioactivity in the water to add much to the misery and suffering which would accompany the other effects. If, as expected, the bomb were exploded a thousand feet in the air, the famous cloud would soon carry all but very small quantities of the activity into the upper atmosphere. The problem for the water works would then consist of restoring pump facilities and repairing mains, with radioactivity a relatively minor worry.

If, by mistake or design, the bomb were set off in a lake or a river, the water would entrap a great deal of the activity. Those who saw pictures of Test Baker at Bikini will recall the tons upon tons of water which were blown into the air. The radioactivity released would be mixed at the instant of the blast with a tremendous quantity of water. In the author's opinion, if such a blast took place in Lake Michigan, the water supply would not become contaminated by a factor greater than 10^5 above lifetime drinking tolerance levels. This figure applies at the time of the blast and assumes that all of the activity is pumped into the water system in one day—an obvious impossibility. During the first 24 hours decay will take

care of a factor of approximately 10^2, leaving a factor of 100. Since, as previously mentioned, the regular treatment processes might be expected to remove 80–90 per cent of the radioactive contamination, the water delivered after the first day—to those consumers who survived the blast—would have an activity level only 10 times as high as the lifetime drinking tolerance. Such water would be less active than the normal supply in some areas. It should be emphasized that this calculation assumes complete mixing and makes certain other assumptions which leave the result subject to an uncertainty of perhaps as much as a factor of 10^2.

It is possible, of course, that "slugs" of activity well above the levels estimated might come through the plant and into the mains unmixed. Such slugs could be detected by ionization chambers (*see* p. 537, *this issue*) set at a relatively high level. Whenever a very high reading was noted, the flow could be temporarily diverted back into the lake at a long distance from the cribs, perhaps to the shore. Such bursts of activity would probably be of short duration, and not much water would have to be diverted.

Although it is possible that for 24 hours it would be well not to drink the water, it should be all right for all other purposes, particularly for fire fighting. (In fact, under emergency conditions, the consumption of water with perhaps 1,000 times the normal activity would be permissible.) Amid all the attendant calamities such a postulated sneak attack would visit upon the population, radioactivity in the drinking water would be about a third-order problem.

Waste Treatment

Of more immediate interest is the treatment of wastes, particularly liquid wastes, regularly produced in more prosaic ways. During the war huge shielded tanks were built to retain the active wastes either indefinitely or until sufficient decay had taken place to allow discharge. At some sites, this practice is still followed. It is, however, a very expensive undertaking.

The current approach is first to segregate wastes into various classes for ease of treatment. Very hot wastes, which are generally also small in volume, are collected in semiportable shielded pots. Intermediate and low-level wastes are collected in nonshielded portable containers. Wastes from laboratory sinks and wash basins are piped to retention tanks, where they are monitored and treated, if necessary, before discharge.

All wastes considered too active for discharge are treated at a central plant. Various processes are used at different sites. Evaporation is quite popular at the moment, and several sites have installations capable of evaporating all or part of their wastes. Some sites, blessed with wastes largely containing a single product, have been able to devise precipitation and coagulation processes. Also under study, though not yet in use on a large scale at any site, are adsorption and ion exchange.

Radioactive wastes are an important problem, and the difficulty of purifying them presents a real challenge. All the answers have not yet been found, but progress is being made and the AEC has been successful in preventing any injurious effects.

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Radioactivity Protection Devices

By Fred R. Ingram

A paper presented on Oct. 27, 1949, at the California Section Meeting, Sacramento, Calif., by Fred R. Ingram, Chief Engr., Bureau of Adult Health, State Dept. of Public Health, Berkeley, Calif.

IN any discussion of the use of monitoring devices for radioactive substances, a few fundamental problems are involved. Problem number one is the type of radioactive exposure concerned. Is the exposure to be measured due to atmospheric or liquid-waste pollution, or is it workroom exposure? Is the cause of the exposure mechanical, as from X-ray machines and shoe-fitting fluoroscopes, or is it from the use of radioactive substances? If the latter, what are the substances and what are their half-lives?

A second problem is the selection of the proper type or types of instruments or other monitoring devices or methods for measuring radiation. Radiation from an X-ray machine originates in the orbital electrons of the atom. An electron impinges on a molecule of some substance (the target of an X-ray tube) and the resulting energy difference results in photon * emission. Gamma rays originate in the nucleus of the atom but act in the same manner as X-rays, so far as their effect on human beings is concerned. On the other hand, alpha and beta emanations are particles, the former being identified as helium atoms carrying a positive electric charge and the latter as negatively charged particles moving at high velocity. Obviously, different instruments, or, at least, different operating characteristics for a given instrument, are necessary to measure the intensities of the several types of electromagnetic waves or effects.

Problem number three is the evaluation of the data obtained with the instruments or measuring devices. It is necessary to recognize the extent or limitation of the meaning of the data and to interpret the findings in terms of potentially harmful effects on living organisms.

The final problem is to determine the methods for minimizing the exposures found and for predicting and controlling possible future foci of dangerous radiation.

Principles Involved

Although photographic film and a few other methods are in use, most radiation-detecting devices depend on the ionization produced in a gas by the radiation. When a high-speed particle or a photon enters a gas, it may act on a neutral atom or molecule with a force large enough to displace an electron and form an ion pair. In the presence of an electric field, the ions will move to the electrode having a charge of opposite sign. If the electrodes are connected to a power source such as a battery, the charge on the

* A quantity of (light) energy, which may be regarded in this context as behaving like a particle.

ions reaching the electrodes will be neutralized, with a resultant current flow through the battery and external circuit. Generally, the current flow will be extremely small, and special measuring devices are required to detect it. Although ordinary current-measuring instruments, with a sensitivity of 10^{-10} amp. at best, are inadequate for measuring such currents, an ionization chamber may be used effectively.

In principle, all ionization chambers are constructed with a sealed exterior shell in which a central collecting electrode is placed, the shell being connected to the negative and the electrode to the positive side of a current source (Fig. 1). Actual designs vary widely,

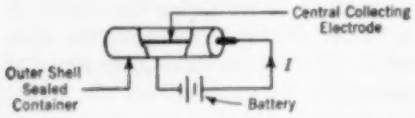

FIG. 1. Ionization Chamber Diagram

depending on the particular type and intensity of radiation to be measured. Short-range radiations may be admitted to the chamber through a thin film or window. If alpha particles are to be measured, the window must be exceedingly thin. Nylon films about 0.0001 in. thick, rendered conductive by a thin coat of colloidal graphite, make satisfactory windows for alpha particles. In general, these chambers operate at atmospheric pressure; hence no differential is encountered which would break the film. Even thin windows absorb an appreciable fraction of alpha particles, however. A 0.0002-in. nylon window will be equivalent to 0.13 cm. of air of density 0.0013, or, to put it another way, an alpha particle from polonium having a range of 3.87 cm. in air would lose about 3 per cent ($0.13 \div 3.87$) of its energy in passing through the window.

An ionization chamber for use with beta particles need not have an excessively thin window, unless very low-energy particles are being measured. The problem here is to obtain a maximum energy absorption in the gas.

High-speed electrons, produced when photons are absorbed by the walls of the ionization chamber or by the gas within it, travel through the gas producing ions until their kinetic energy is spent. All the ions produced can be collected and thus measured to determine the exposure.

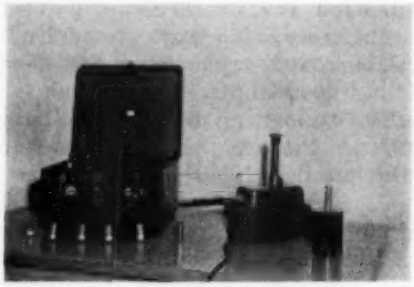

FIG. 2. Electroscopic Equipment

Electroscope

Instruments for measuring the amount of electric charge collected in an ionization chamber are called electroscopes or electrometers. For present purposes, an electroscope is an instrument which does not require a continuous external voltage for its operation. The Lauritsen * electroscope is one of the most generally useful instruments for radiation measurements. A wire is bent in the form of an L and mounted on the electroscope

* A product of Fred C. Henson Co., Pasadena, Calif.

case through an insulating bead of quartz or amber. The moving system is a quartz fiber about 5 μ in diameter, made conducting with a thin metal coating and fastened to one arm of the L. A second fiber is fused to the free end to form a T in order to make the first fiber visible in the microscope. The electroscope is charged by touching one arm of the L with a wire from a battery. Mutual repulsion forces the quartz fiber to deflect away from the side of the L. When subjected to radiation, ions formed inside the case neutralize the charge and the fiber moves back again toward its uncharged position. The amount of neutralization may then be read from a calibrated scale in the microscope as a measurement of the total radiation. Knowing the time of exposure, the rate or dosage of the particular radiation may be calculated.

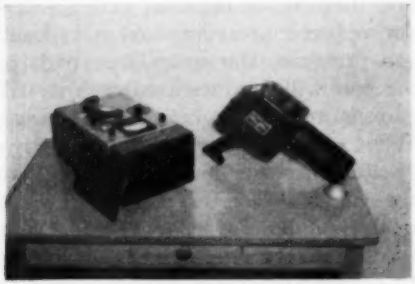

FIG. 3. Ionization Chambers

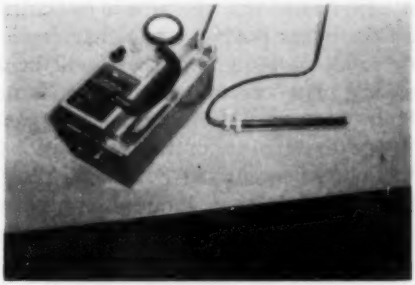

FIG. 4. Geiger Counter

There are several types of electroscopes and several types of instruments using the electroscope principle. The pocket dosimeter is essentially a pencil type electroscope with a built-in microscope. Another pencil type dosimeter does not have the built-in microscope and scale but must be returned to the charging unit for reading. This is the principle of the Victoreen * minometer (Fig. 2) used by the California Bureau of Adult Health. Figure 2 shows the charger and reader in the center, an 0.01-roentgen tube at right, and 0.1- and 0.2-roentgen pencils at left, in front of the case.

Electrometer

Electrometers measure the electric charge or potential through the action of electrostatic forces on a fiber or light-conducting vane. An external potential applied to auxiliary electrodes produces a greater sensitivity than is usual for electroscopes. Many types have been developed, but they are essentially laboratory instruments particularly suitable for measuring low-energy beta or alpha particles. The Wulf * string electrometer and the Lindemann † electrometer are two useful instruments in this group.

Ionization Chamber Amplifier

Vacuum tubes can also be used to measure ionization currents. A distinct advantage is the elimination of microscopes or other optical systems required for reading electroscopes or electrometers, thus making the vac-

* Victoreen Instrument Co., Cleveland.
† Cambridge Instrument Co., New York.

uum tube amplifier a very desirable choice for portable survey meters. In principle, the operation depends on the ionization current flowing through a high resistance so that a potential difference can be impressed on the grid of the tube. The resulting plate current change can then be measured with a small, rugged portable microammeter. Care must be exercised in choosing the vacuum tube or tubes and circuit if satisfactory operation is to be obtained, and they must be selected for operation with very low electrode voltages. Residual grid current should be as low as possible, even down to 10^{-15} amp. The grid voltage is adjusted so that the tube is operating on the linear portion of its characteristic, and, consequently, there will be a steady plate current when there is no ionization current. The meter is adjusted to zero under these conditions, so that, when current flows as a result of ion production induced from the radiation, an unbalance occurs in the circuit and the meter will deflect.

Ionization chambers are made in a wide variety of shapes and sizes. For alpha particle measurements, it is well to have the chamber as shallow as possible to reduce the response to beta, gamma and cosmic radiation with no loss in alpha particle sensitivity. Ionization chambers can be used to measure alpha particles in the presence of beta and gamma radiation, if the latter is not too strong. The chamber must be equipped with a very thin window through which all particles can penetrate into the chamber. The alpha particle will produce 10^5 ion pairs over a very short path, a beta particle will produce 10^2 ion pairs in traversing the entire chamber and a gamma ray will produce a high-speed electron which will then ionize like a beta particle. The chamber therefore responds selectively to alpha particles. By covering the window with a thin shield, alpha particles may be excluded and response will be to beta particles. A thicker shield will stop the beta particles, and any ion current then will be due to gamma rays. Figure 3 shows two ionization chambers. At left is the Beckman MX-2 Beta Gamma Survey Meter *; at right, the Tracerlab "Cutie Pie" Survey Meter.†

Geiger Counter

The Geiger counter takes advantage of the enormous amplification of ionization that can be obtained in a gas under reduced pressure. At a reduced gas pressure, the mean free path of the ion will be increased and it will gain more energy between collisions. When an ion has a kinetic energy greater than the ionization energy of the gas molecules, it may ionize the neutral molecule by collision. The secondary ions thus formed will in turn be accelerated by the field and produce further ionization. The cumulative increase of ions is called avalanche ionization, and it is this gas amplification factor which is made use of in Geiger counters.

Geiger counter tubes are made in various shapes and sizes, but usually consist of a cylindrical cathode with an axial wire 0.003–0.01 in. in diameter. With a gas pressure of about 10 cm. Hg, a large gas amplification can be obtained if the central wire is 200–1,500 v. positive with respect to the cylinder. All counter tubes are connected to some sort of electronic hook-

* National Technical Laboratories, South Pasadena, Calif.

† Tracerlab, Inc., Boston, Mass.

up that can be adjusted to respond only to pulses larger than a desired size. If the circuit is adjusted to respond only to pulses produced by an avalanche of 10^8 ions or more, then the counter will detect alpha particles selectively in the presence of high intensities of beta and gamma radiation.

According to Lapp and Andrews (1) the gas amplification factor, A, in the proportional region where the avalanche ionization is restricted to the immediate vicinity of the primary ionization, is about 10^3, so that an alpha particle that produces 10^5 primary ionizations will result in a pulse corresponding to 10^8 and will be counted. A typical beta particle that might produce 10^2 primary ion pairs would result in a pulse corresponding to only 10^5 ions and the instrument would not respond. Similarly, from gamma radiation, the primary yield would be 10^2 primary ions and would result in 10^5 ions in the avalanche. The proportional region is mentioned here since the better alpha counters are designed and built to operate in this region.

The value of A is a function of the voltage applied to the tube. As the voltage is increased, the Geiger-Muller region is reached, where the avalanche does not confine itself to the area near the original ionization but spreads along the entire length of the central wire. The size of the output pulse is therefore independent of the number of primary ions and the tube does not distinguish between the various types of radiation. One valuable Geiger counter characteristic is that an increase in voltage above the point at which practically every particle entering the tube is counted does not change the count rate appreciably. Consequently, accurate results are not dependent on strict voltage control. This plateau usually extends over about 200 volts and is the area in which the instrument is designed to be operated.

Ordinary tank argon of about 99 per cent purity is the most popular filling gas. For counters having self-quenching circuits, a 9:1 mixture of argon and ethyl alcohol at 10 cm. Hg pressure is often used.

Several circuits may be used for recording the pulse, one of which employs a mechanical counter either to record directly or to provide an aural count through earphones. As mechanical registers perform more satisfactorily if they do not receive over 50 impulses per second, scalers must be used in order to record only a small fraction of the total input pulses. By constructing a series of such circuits, the incoming pulses can be reduced by a factor of 2, 4, 8, 16 and so on. The most common scaling is to a 64 factor, although higher scale circuits are used when very high counting rates must be recorded.

For some purposes, it is advantageous to know the rate at which pulses are received. Such instruments are called counting rate meters. The Beckman MX–5 GM Radiation Meter * shown in Fig. 4 is of this type.

Film Badge

The film badge is a monitoring device which may be used for detecting radiation in specified locations but is most commonly employed in personnel monitoring. When individuals may be exposed to small amounts of radiation, wearing a film badge on the part of the body most likely to receive the greatest exposure is an added pro-

* National Technical Laboratories, South Pasadena, Calif.

tective feature in monitoring the area and equipment.

Photographic-film meters are usually made into packets of dental-film size and are covered with an opaque wrapping to protect the film from visible light. Any desired combination of emulsions can be put into a single packet. Shields of different metals or other materials covering portions of the sensitive area of the film are employed to stop the several types of radiation. The unprotected portion will be darkened from the effects of all radiation. The first shield, of very thin material, will stop the alpha particles, permitting a darkening due to beta particles and gamma rays. The next shield, partly overlapping the first, will stop the beta and alpha particles, so that the resulting darkening of the film will be due to gamma radiation, if any is present.

Films should be worn close to the body to obtain the maximum effect. A packet is ordinarily worn for one or two weeks, depending on the nature of the exposure, after which it is returned to the laboratory for processing and reading. The amount of darkening is an indication of the amount of radiation exposure.

Although not so sensitive or so accurate as some of the electronic equipment, film badges do have certain advantages. They are small, can be easily worn for a long time and iutegrate the exposure during any desired period. Disadvantages include the nuisance of processing, the care required to obtain significant results and the time lag between exposure and return of results.

Effect on Health

The mechanisms by which high-energy radiations are absorbed have been mentioned briefly. High-speed charged particles, such as alpha and beta radiation, penetrate only relatively short distances before all of their energy is expended in producing secondary ions. The hazards due to charged particles from external sources will be confined to a thin layer of tissue. If alpha- or beta-emitters get into the body, they will concentrate at places determined by the nature of the material and will produce injury at those sites.

An often overlooked fact is that radiation produces effects only through absorption. If a gamma ray passes through the body with no loss of energy, it produces no effect. Only those photons which interact with the tissue and lose energy produce biological effects. The ions produced by the photon-electron interactions will move only short distances from the point at which they were formed, but they will be formed fairly uniformly throughout the body, and, hence, all tissues will be exposed to injury.

For some time a maximum dosage rate of 0.1 roentgen per day has been

TABLE 1

Maximum Permissible Dosages

Type of Radiation	Quantity		
	rem, per day*	*rep,† per day*	*rem,* per week*
X-ray	0.05	0.05	0.30
Gamma	0.05	0.05	0.30
Beta	0.05	0.05	0.30
Alpha	0.01	0.01	

* "Roentgen equivalent man"—that quantity of radiation which, when absorbed by man, produces an effect equivalent to the absorption by man of one roentgen of "X" or gamma radiation.

† "Roentgen equivalent physical"—a quantity of radiation which produces a specified amount of ionization in tissue.

observed as a tolerance level for exposure to gamma or "X" radiation. Recent information shows that even this dosage has resulted in blood changes. In March 1949 the Bureau of Standards issued a handbook (*2*) which recommended a dosage rate of 0.300 roentgen per week, based on a constant dosage rate throughout a 48-hour week. Taking a cue from these data, the Div. of Industrial Safety of the California Dept. of Industrial Relations has proposed to its safety board the maximum permissible dosages shown in Table 1.

Determination of the amount of radioactive material stored in the body is not easy, since calculations must be made from measurements of the radioactivity of urine and expired air. Sometimes the rates of excretion are very slow and measurements must be made on a low-activity basis. Analyses of expired-air samples necessitate elaborate and expensive equipment, and there is still some debate among authorities on the adequacy of the results. Some standards have been set for radioactive atmospheric contaminants such as radon and thoron gas and radioactive dusts. Air samples may be collected by an electrostatic precipitator and then checked with one of the instruments described above, but this method leaves much room for improvement. For alpha-emitters, the Div. of Industrial Safety has established that 5×10^{-12} microcuries per cubic centimeter should be the tolerance level, and, for beta- or gamma-emitters, that 10^{-9} microcuries per cubic centimeter should be the maximum exposure acceptable.

High-energy radiations are among the most insidious destructive agents for living tissue. Except for exceedingly high doses, the effects are delayed for periods varying from a few days to several years. In spite of this insidiousness, however, work can be carried on safely with any amount of radioactive material, if proper precautions are taken. It is imperative for all workers using radioactive materials or operating equipment from which ionizing radiation might emanate to know of the dangers associated with their work, to be aware of the adequacy of the control methods and to take the precautions necessary. If these simple but broad rules are met, injury will be avoided.

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Prestressed Concrete Reservoir for Milwaukie, Oregon

By H. Loren Thompson and Leonard Cross

A revision of a paper presented on May 13, 1949, at the Pacific Northwest Section Meeting, Bellingham, Wash., by H. Loren Thompson, Partner, Stevens & Koon, Portland, Ore., and Leonard Cross, Constr. Engr., E. E. Settergren, Portland, Ore.

IN September 1949 Milwaukie, Ore., placed in service a 1.5-mil.gal. prestressed concrete reservoir, the total construction cost of which was $65,000, or 4.3¢ per gallon of storage capacity. At 1949 construction prices, this figure was a very favorable one and reflected the confidence of contractors in the economy of prestressed concrete reservoir construction.

There were eleven bids, ranging from the above figure to $99,486, with five below $73,000. The successful contractor was E. E. Settergren of Portland, Ore. The unit prices of the major items involved were:

Concrete dome	$7,318.00
Concrete for floor slab and footings (per yard)	37.75
Concrete for core walls (per yard)	50.00
Reinforcing steel (per pound)	0.125
Special high-strength square steel bars for prestressing	9,296.00

The last item consisted of 35 tons of special steel bars, which, on a unit price basis, cost 13.3¢ per pound in place, the lowest bid on this item. The bars, which were of two sizes—1¼ and 1 in.—were square with upset ends having machine-cut threads. The minimum elastic limit and ultimate strength of the bars were 55,000 and 85,000 psi., respectively. All steel bars were furnished by the Bethlehem Pacific Coast Steel Corp. and were fabricated at its Seattle plant.

Many prestressed tanks of the "Hewett" design have been constructed throughout the country. The Milwaukie tank is the first of its kind constructed in the Pacific Northwest using the anchorage methods developed by R. C. Kennedy (1). As the structural analysis for a prestressed tank of the type used has been published in numerous articles and in special bulletins of the Portland Cement Assn., this paper will be confined to details of design and to construction methods.

Design and Construction

The foundation was poured as an entirely separate ring. The surface of the foundation ring on which the core wall was to rest was coated with asphalt so that no appreciable bond would develop between the concrete surfaces. The floor slab was poured next. The details at the junction of the core wall, floor slab and foundation are shown in Fig. 1. Although the floor slab is not tied to the foundation, a "shear shoulder" is shown which does tend to prevent relative horizontal motion between the two units of the structure. This shoulder was used because it increases the ability of the structure to resist lateral forces.

A watertight joint between the core wall and the floor slab was achieved by employing a rubber water stop. A half-oval steel strip above and below the rubber stop permitted bronze bolts to be tightened to force the rubber against the side walls of the concrete surfaces. Observation in the field indicates that $\frac{1}{2}$-in. bronze bolts on approximately 6-in. centers should be used for this purpose. A larger spacing permits the half-ovals to spring up midway between the bolts and thus reduce the pressure against the walls.

outside forms. The contractor's cost for material for the plywood forms was 45¢ per square foot of form built. The actual labor cost on the forms averaged 20¢ per square foot per setup, with the first move costing 24¢. The average cost of moving the forms into place for the sixth and seventh moves was 14¢ per square foot. The average of 20¢ per square foot per setup included the initial cost of labor on construction in place.

The inside-wall form was securely fastened to horizontal framing which

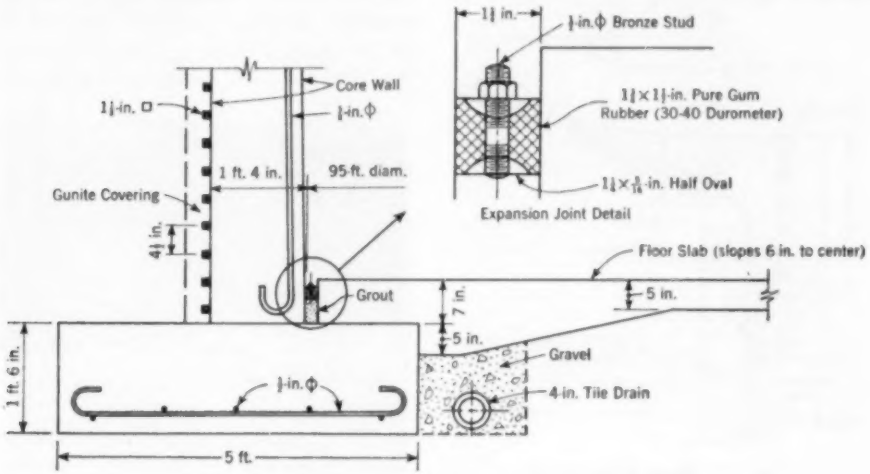

FIG. 1. Juncture of Slab and Core Wall

If poured joints were used, the material would, as a minimum requirement, have to adhere well to concrete and not lose its elastic properties with age. A rubber compound having a specific gravity greater than water should prove satisfactory, but a cement grout joint would not, since there always will be a slight horizontal movement of the core wall due to changing pressures within the tank, with resulting cracks and some leakage.

The core wall was poured in eight sections, using one set of inside and

pivoted about a pin held at the center of the tank by means of structural angles fastened to the center drain well. The inside form was moved first, and all reinforcing bars which were to be embedded in the concrete were placed against this form. Then the ouside form was rolled to its final position. Heavy steel rod ties were used with the previously poured section acting as one bulkhead. Galvanized sheet metal water stops were employed in each vertical joint.

Concrete was poured through open-

ings at two levels and through the top of the forms, with elephant trunks on the inside to reduce the distance the concrete was dropped. A gasoline-driven generator provided power for the electric vibrator, which was handled by one man from a platform at the top of the 30-ft. wall. By using a vibrator which had a motor and head weighing only 13 lb., excellent consolidation of the concrete materials was achieved without undue strain and exertion on the part of the operator.

Figure 2 depicts a section of the dome ring showing the juncture of

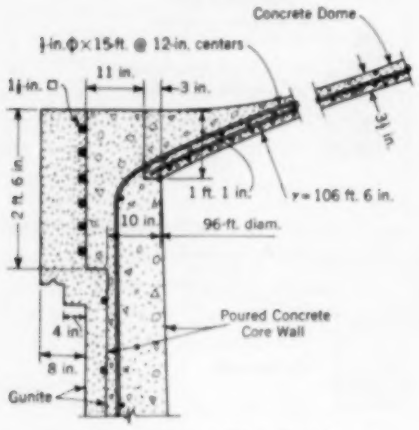

FIG. 2. Dome Ring Detail

the dome and core wall. The falsework for the dome consisted of one main, center 10 × 10-in. wood column, several 4 × 4-in. columns, lateral struts and ties, and three circular (360-deg.) laminated wood beams. Radial joists were supported by the circular beams, with 1-in. shiplap used as a surface skin to complete the form for the spherical dome. The steel and the dome form are shown in place in Fig. 3. The pouring of the dome began at 8 A.M., and the entire dome was finished by 4 P.M. of the same day.

The rise in the dome is 11 ft. 5 in. At about 5 ft. above the wall level, a circular runway, 4 ft. wide, was constructed for the concrete buggies. The pour for the first concentric ring progressed in both directions from the starting point until the ring was completed. The upper edge of the poured ring was maintained "alive" by adding a small amount of concrete along the edge to prevent a "cold" joint at the junction with the second concentric ring. Another circular runway was provided about 4 ft. above the first for the second concentric ring to be poured. The final ring was poured up to the lantern using the same runway. A Mixermobile * with elevator was

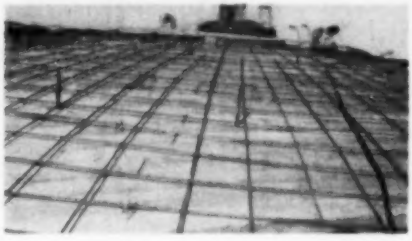

FIG. 3. Falsework and Steel in Place

employed to hoist the concrete to the runways on top of the dome, as shown in Fig. 4. Ready-mixed concrete was used throughout on all pours.

All concrete was water cured. For the dome, a revolving irrigation sprinkler was located at the lantern, augmented by a 50-ft. section of "soil soaker" to offset the effect of the wind.

Prestressing Operations

After the concrete in the dome had been cured for a period of 21 days, the special steel bars were placed and prestressing operations began. Seven bars were used in the circumference

* Mixermobile Mfrers., Portland, Ore.

of the tank. The detail plans provided for a vertical steel beam through which the bars were threaded (Fig. 5 and 6). The nuts were tightened to almost the desired stress by a ratchet wrench (Fig. 7), and the final stress was attained by the use of a special wrench provided with a shear pin. This wrench was made so that an internal couple (torque)

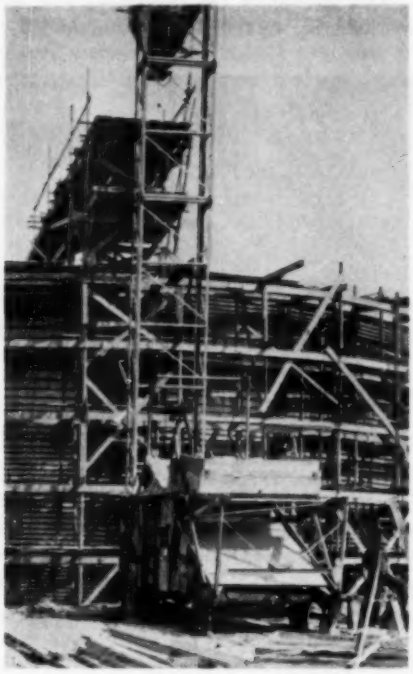

FIG. 4. Materials Handled by "Mixermobile"

was developed with the two forces applied, one at a large shear pin and the second at a 12-gage steel wire shear pin. When the magnitude of the couple reached a predetermined amount, the steel wire used as a shear pin failed. At the point of failure, the stress induced in the steel bars approached 31,000 psi. with a high degree of accuracy.

The special wrench follows the general design of that used by Kennedy (1), but, as different sizes of bars were involved, the proper distance between the pins had to be determined. At the outset, certain friction factors were assumed to apply to the threads and between the washer and nut. The wrench was then made to this specification and checked in the field against a mechanical strain gage and, also, against the total deformation in 40 ft. Based on these results, a new dimen-

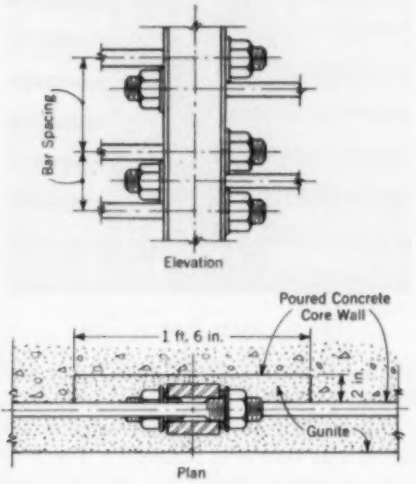

FIG. 5. Connecting-Beam Installation

sion was determined and the wrench was adjusted to provide the proper distance. The wrench was checked again and found to induce the desired stress in the bars tested. For prestressing the 1-in. bars, this critical dimension was determined by proportion and tested satisfactorily.

Work on prestressing started at the bottom of the tank, proceeding around it and upward until the ring dome was reached. The process was repeated three times to assure that unequal stresses which developed in the

bars as the work progressed were equalized throughout. The six 1¼-in. ring dome bars were tightened in the same manner. During the tightening of these bars the dome rose and the lantern was finally about $\frac{3}{16}$ in. above its original position. Thus, the dome released itself from the falsework, making it a very simple job to remove the forms, although the shiplap forms were

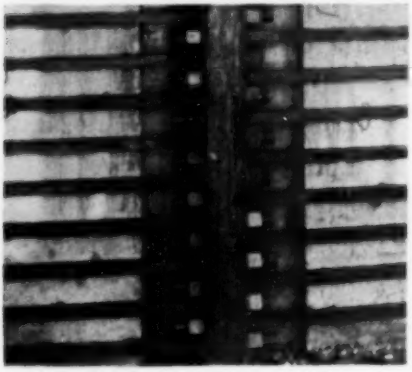

FIG. 6. Steel Bars in Place

so loose that care had to be taken not to let them drop indiscriminately.

Almost all of the falsework for the dome was removed through a 4 × 8-in. wedge-shaped hole left in the wall about 5 ft. above the floor slab. The remainder of the falsework was removed through the hatchway. The wedge-shaped opening was to be filled with Embeco * grout, but, instead, it was shot full of gunite with no means of removing rebound. As a result, leakage appeared around the edges and it became necessary to replace the gunite with Embeco grout as originally planned. The total leakage before the change was made was 3½ in. over a period of fifteen days, or about ¼ in. per day.

The design of the reservoir was the work of H. Loren Thompson, and the

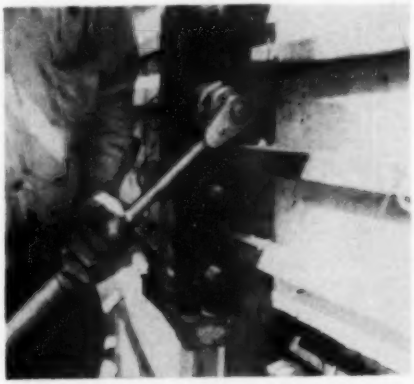

FIG. 7. Ratchet Wrench

reservoir was erected under the supervision of Leonard Cross. The entire project was carried out under the general direction of Jack A. Taber, City Mgr., Milwaukie, Ore.

* A product of Master Builders Co., Cleveland, Ohio.

Reference

1. KENNEDY, R. C. Design and Construction of Prestressed Concrete Tanks. Jour. A.W.W.A., 37:73 (Jan. 1945).

Discussion

Gordon G. Ingman

Cons. Engr., Parker & Hill, Seattle, Wash.

Fifteen years' experience in the design and construction of prestressed concrete tanks has indicated certain advantages in the use of steels which are capable of developing ultimate stresses in the range of 200,000 psi. The primary objective in the prestressing of concrete to be utilized in the construction of circular reservoirs subjected to hydraulic loadings is to im-

part sufficient initial prestress to the steel to insure compressive stresses in the concrete which will provide for all live loads plus possible stress losses. Concrete, as is well known, is incapable of developing tension stresses of any magnitude much in excess of 5–10 per cent of its ultimate compressive strength. For this reason, and since the design of circular reservoirs in the conventional manner requires the use of sufficient steel to reduce cracking in the shell wall to a degree minute enough to prevent leakage, the advantage of a shell wall constantly under compressive load becomes obvious, especially when substantial savings in steel weight can be achieved through the prestressing method.

The designers' problem may be briefly stated in the form of an equation:

$$f_{si} = f_u + f_L$$

in which f_{si} represents the total initial prestress to be imparted to the banding steel; f_u, the stresses due to live loads; and f_L, the stress losses due to the physical characteristics of the materials used and the influence of environment on them.

Stresses due to f_u in the above equation are quite readily computable from fundamental mechanics formulas and from the work of the Portland Cement Assn.

Stress losses (f_L) may be of considerable magnitude, as subsequently set forth. Early prestress designs neglected these stresses, as they were believed to be of small or negligible value. The Europeans, Billig and Freysinnet, and the American, Jackson, found that concrete, as well as steel, undergoes a definite volume change due to shrinkage and plastic flow. Among the losses composing f_L are shrinkage, plastic flow, temperature differential and initial compression. Considering these singly, the following effects become apparent:

1. Shrinkage in dense concrete, according to Billig (1), may be about 0.03 per cent, which is equivalent to a stress decrease of 9,000 psi. in the steel.

2. Plastic flow in concrete, it has been reported, may, after one year, reach a value of 9×10^{-7} for a stress of 1 psi. Translated into terms of stress, a possible prestress loss of about 18,000 psi. in the steel is indicated. Plastic flow in the steel is not nearly so high, and less than 3 per cent of the initial prestress may be expected to be lost due to this phenomenon. For example, utilizing high-strength cold-drawn wire at an initial prestress of 140,000 psi., the loss due to plastic flow of the steel would be on the order of 4,000 psi.

3. Temperature differentials between the prestressing steel and the concrete of the tank shell may cause a prestress loss on the order of 10,000 psi.

4. Loss in prestress due to initial compression of the tank shell is likely to occur, especially if the tank wall is constructed in separately poured segments. The loss of prestress in the steel due to such initial compression is likely to be in the neighborhood of 2,000 psi.

A summation of the apparent losses composing f_L would, then, be as follows:

	psi.
Shrinkage (concrete)	9,000
Plastic flow (concrete)	18,000
Plastic flow (steel)	4,000
Temperature differential	10,000
Initial compression	2,000
Total f_L	43,000

From the foregoing, it is obvious that accumulated losses may result in lowering the value of the prestress

initially imparted to the steel as much as 40,000 psi. Since the commercial grades of reinforcing steel usually employed have a yield point between 30,000 and 40,000 psi., the advantage of high-yield-point steels becomes apparent. For instance, high-carbon steel wire with a yield point of 175,000 psi. and a working stress of 100,000 psi. would have a safety factor of 1.75, compared with one of 1.83 for a commercial-grade, conventional reinforcement steel with a yield point of 33,000 and a working stress of 18,000 psi. But in the high-carbon steel wire there would be an unused stress of 75,000 psi., as against only 15,000 in the conventional reinforcement steel.*

The above indicates the inadvisability of attempting to utilize commercial grades of steel rods for prestressing purposes. Although high-carbon steel with a yield point of 175,000 psi. is not readily obtainable in rod form, experimentation has resulted in the development and use of high-carbon cold-drawn wire. There are several other advantages to high-carbon cold-drawn wire construction:

1. The prestressing of individual rods uniformly to a predetermined initial load presents a much greater field problem than does the prestressing of wire.

2. The use of rods requires a much deeper, or heavier, protective coating than does wire reinforcement.

3. The loss of prestress in a single rod for any reason will be much more serious than in a wire. Tests have indicated that the accidental cutting of a wire strand will not cause a decrease in stress in the wire beyond a point 4–6 in. from such a cut.

4. Wire has the advantage of speed in construction.

5. Certainty of initial preload is provided in wire construction by drawing the wire through a carbaloy die of slightly smaller diameter than the stock wire (*2*). It is interesting to note that drawing the wire raises its temperature about 250°F. When the original wire diameter is equal to 0.162 in. and the final drawn diameter is equal to 0.144, the initial prestress of 100,000 psi. required by the drawing operation will yield a final stress of about 140,000 after the wire has cooled.

The wall, or shell, material for prestressed tanks can be constructed from either concrete or machine grout, but some advantage has been claimed for the latter. Comparative tests have shown that concrete may shrink approximately one-third more than machine grout and that the plastic-flow percentage in concrete is higher. In general, however, the availability of aggregates and skilled labor will dictate the material to be used.

Prestressed circular concrete tanks will show a saving in materials, concrete and steel, as opposed to circular concrete tanks of conventional design. Moreover, since the concrete of the shell wall is constantly under compressive stress, there is less likelihood of leakage in the prestress design.

* Billig, an internationally recognized authority on prestress construction, stated in November 1949 that current construction standards in England called for steels with a yield point of not less than 80 long tons per square inch, equivalent to 179,200 psi.

References

1. Billig, Kurt. *Prestressed Reinforced Concrete.* F. Billig, Jamaica, N.Y. (1943).

2. Knight, M. G. & Ingman, G. G. Prestressed Concrete Reservoirs at Grand Coulee. Pacific Builder & Engr., p. 76 (June 1948).

Field Test of a Cathodic Protection Installation

By H. A. Sweet

A report, No. 11404, dated May 5, 1949, of a field test made at the Union Mills Paper Mfg. Co. Plant, New Hope, Pa., by H. A. Sweet, Engr., Standards Dept., Factory Mutual Eng. Div., Boston, Mass.

CATHODIC protection listed in the Factory Mutual Laboratories' "Approved Equipment Bulletin" was installed about 1938 in a steel water tank of the Union Mills Paper Manufacturing Co. at New Hope, Pa. Following apparent continued rusting with the cathodic protection installed, it was decided to conduct a field test in order to decide whether or not the equipment furnishes adequate protection against corrosion.

Description of Test

Small pieces of steel plate were placed in the water of the steel tank to investigate the effectiveness of the existing cathodic protection. The tank, a 75,000-gal. structure on a 25-ft. steel trestle, stores water from the nearby Delaware River. This water has relatively low alkalinity and hardness but a relatively high sulfate and carbon dioxide content.

Pairs of mild-steel specimens, 2 in. × 4 in. × 14 gage, were placed in three locations—1½, 6 and about 11 ft. from the top of the tank cylinder, which is 15 ft. deep and 26 ft. in diameter. At each location, one specimen was bolted tightly to a cleaned inside ladder side bar, between the tank plate and the ladder, so as to be considered in the tank shell circuit and thus affected by the cathodic protection. The other specimen at each location was hung on a glass hook without connection to the tank shell and thus was not a connected part of the tank circuit. Specimen faces were placed parallel to the tank plates.

The specimens were installed in the tank on July 2, 1948. During normal use of the tank for mill service and continuous operation of the cathodic protection equipment, the specimens were not disturbed, except as stated below, until removal on October 26, an interval of 116 days or about four months. Upon removal of the specimens, the ungrounded or unprotected specimen on a glass hook near the top of the tank was missing. It was found at the bottom of the tank, but the length of time it lay in this location is unknown. The ungrounded specimen at about middepth of the shell cylinder was also missing and was not found.

The specimens were hot rolled, corresponding to about S.A.E. (Society of Automotive Engrs.) 1010. Mill scale was buffed to give bright metal at the start. The tank shell plates probably meet A.S.T.M. Specifications A7.

On the recommendation of the Massachusetts Institute of Technology Corrosion Laboratory, the specimens were cleaned cathodically. The solution in which they were immersed contained 5 per cent sulfuric acid, by weight, and 0.5 g. per liter of betanaphthol corrosion inhibitor. The specimens were made the cathode, the anode being lead. The

cathode current density was 1.3 amp. per square inch, and the current was applied for approximately five minutes. The solution temperature was 160°F.

During the cathodic cleaning the loss in weight of the base metal would approximate 0.8 mg. per square decimeter. In comparison to the losses involved by submergence in the tank—from 2,100 to 155 mg. per square decimeter—the cleaning loss would be almost negligible.

In order to determine if the glass hooks which supported the ungrounded specimens could carry any current and thus furnish partial cathodic protection to the specimens, tests were made on the hooks when dry, wet (not submerged) and submerged in water. The resistances found were infinity, 10,000,000 ohms and 3,000 ohms (estimated), respectively.

The results of the 116-day test are shown in Table 1. Data are not given for the specimens located near mid-depth because the ungrounded specimen was missing, as previously mentioned.

Remarks

1. As the chemical composition of the specimens doubtless varied minutely from that of the supports holding them, there might have been small local differences in potential which may explain why the corrosion of the grounded or protected specimens was not negligible—that is, the impressed cathodic current may not be sufficient to prevent such action on these specimens.

2. The specimens were located in an unfavorable part of the tank, partly back of the ladder side bars, so that the ladder may have prevented the specimens from receiving as much protection as other parts of the tank shell.

3. The current leakage resulting from using glass hooks was very minor. If of any effect, it would tend to furnish small cathodic protection and therefore decrease slightly the amount of corrosion on the ungrounded or unprotected specimens.

4. The frequent change of water and the presence of some ice in winter are unfavorable for continuous tests of specimens. It is probable, however, that lengthy tests would bring out more marked results.

Conclusions

1. The cathodic protection being furnished by the equipment installed was definitely of value in reducing the rapidity of corrosion of the specimens tested in the tank during a period of about four months.

2. Near the top of the tank, the unprotected specimen, representing the tank without cathodic protection, corroded about seven times as rapidly as the grounded or protected specimen. Near the base of the cylinder of the tank, the unprotected specimen corroded about four times as rapidly as the grounded or protected specimen.

TABLE 1

Results of Test

	Specimen			
	Near Top		Near Base	
	Protected	Unprotected	Protected	Unprotected
Weight				
At start—*g.*	77.9617	72.2602	74.4491	71.5979
At end—*g.*	77.8002	71.1138	73.8846	69.2973
Loss—*g.*	0.1615	1.1464	0.5645	2.3006
Loss—*per cent*	0.21	1.59	0.76	3.22
Net exposed area—*sq.in.*	16.205	16.280	16.404	16.794
Weight loss—*g./sq.in.*	0.010	0.070	0.034	0.137

Experience With Cathodic Protection

By James W. McAmis

A paper presented on Nov. 1, 1949, at the Kentucky-Tennessee Section Meeting, Lexington, Ky., by James W. McAmis, Secy.-Treas. & Supt., Water & Light Com., Greeneville, Tenn.

GREENEVILLE, Tenn., first became interested in cathodic protection in 1940. The city has two standpipes, each 30 ft. in diameter, one 60 ft. high and the other 65. The older tank, built in 1917, was originally coated with a coal-tar paint which gave good protection for approximately twenty years. Graphite and aluminum paint was applied to the second tank at the time of construction, 1924. When it was drained and inspected the following year, it was found to be in deplorable condition. It would be difficult to imagine the amount of soft, spongy rust which had formed on the walls. Two or three handfuls could be wiped off within a space 6 in. square. Various methods of combating the conditions in this tank were tried but proved only partially successful. Consequently, in 1938 the tank was drained and the entire inside surface was sandblasted and painted with one coat of chromate primer and two coats of synthetic-resin paint.

Cathodic Protection Adopted

The older tank had begun to need attention, and cathodic protection was considered in 1940. It was learned that the installation cost would be $475 for the older tank, with a rectifier of sufficient capacity to take care of the new tank when required. The operating cost was estimated at $3.00 a month. A contract was made carrying an unlimited guarantee of satisfaction, with the provision that Greeneville was to bear the expense of installing the system in the new tank.

It has since developed that the company which furnished the cathodic protection was too optimistic about the amount of current and the number of electrodes needed. The first installation was made by suspending one electrode of ¾-in. stainless steel in the center of the tank and applying a 3-amp. current to it. In addition, some small pieces of ⅜-in. steel plate were suspended in the water and electrically connected to the body of the tank. Their purpose was to indicate whether or not the tank was receiving protection, as they could be removed for inspection without draining it. These samples never did show any indication of corrosion, but, when the tank was finally drained, after about 1½ years, it was found to be receiving very little or no protection. A section of the tank wall, about 3 ft. square, which had been cleaned at the time cathodic protection was installed was corroded and pitted just as much as the rest of the tank. On being notified, the company, at its own expense, changed the number of electrodes to three, equally spaced around the perimeter of the tank,

and increased the capacity of the rectifier.

When the second set of electrodes had wasted away and dropped off the hangers, they were replaced, at Greeneville's expense, with ¾-in. black iron pipe, as no stainless steel was then available because of the war. Later, possibly in 1945, without instructions from the company, the current was increased and electrodes were hung in the new tank as a precautionary measure. In 1946 and 1947 the water was drawn down part way and an inspection was made at the 30-ft. level. The new tank was found to be still in perfect condition, while corrosion in the old tank was proceeding at a somewhat reduced rate, as evidenced by the condition of the nodules or tubercles of rust which invariably form over pitted spots. Experience has shown that, when corrosion is rapid, the tubercles will be soft and spongy, allowing the water relatively free access to the sound metal. If the rate is greatly retarded or has been arrested entirely, however, the tubercles are hard and dense, tending to seal the metal away from the water.

New Installation

During the later war years and the immediate postwar period both the company and the city were so short of labor and materials that the project was somewhat neglected. By this time it had become obvious that the difficulty in obtaining complete protection resulted from an inability to supply sufficient current to stifle the tendency of the iron tank to corrode. Toward the end of 1948 the company sent a crew of men and the necessary materials to Greeneville. The company furnished a new rectifier for each tank and the materials and labor to install four aluminum electrodes for the older tank, while the city paid for the materials and labor to equip the new tank in the same manner.

The tanks were drained one at a time, and inspection disclosed that the paint job in the new tank was still in perfect condition. The older tank was also found in good shape, as the tubercles were all hard and dense and a grayish coating was forming on the spaces between them. The gray coating is taken to indicate that dependable protection has at last been obtained. This statement does not imply that the problem can now be forgotten; the electrodes must be renewed periodically and the rectifiers and other equipment kept in good operating condition.

Although sufficiently detailed records for an accurate and direct comparison of painting and cathodic protection costs are not available, cathodic protection is believed to be somewhat cheaper and a good deal less trouble.

Iron and Carbon Dioxide Removal

By Gerald E. Hauer

A paper presented on Oct. 11, 1949, at the Southwest Section Meeting, Oklahoma City, Okla., by Gerald E. Hauer, Chief Engr., The American Well Works, Aurora, Ill.

PROGRESS in the improvement of methods and equipment for water purification has been followed by an ever increasing demand for water of greater purity. Specifications have become more rigid, industry more and more requires a water of exceptional purity and the average citizen is no longer satisfied with an unpalatable and stain-forming water, such as that characterized by a high iron and manganese content.

Iron removal, and the carbon dioxide removal closely associated with it, have become a matter of economic importance. Since 1868, when the first reported iron removal plant was built, a vast amount of knowledge about and experience with the process has been recorded. The past few years, in particular, have witnessed the development of more rapid and economical methods. The fundamental theories, however, have remained practically unchanged. A brief review of the various aspects of iron and carbon dioxide removal, especially from well waters, may serve to stimulate interest in this type of treatment.

Status of Treatment in Southwest

A total of 177 sources of supply was reported for Arkansas by the U.S. Public Health Service 1945 inventory (1). Of these, 132, or approximately 75 per cent, were wells. In general, it can be said that these ground water supplies are found east of a line drawn from the northeast corner to the southwest corner of the state. In practically all of the well supplies, the iron is in suspension, with only a few having any in solution.

Complete data furnished by the Arkansas Board of Health show 31 treatment plants for the removal of iron and carbon dioxide from well water. This figure represents about 23.5 per cent of the total well supplies or 17.5 per cent of all sources combined. The maximum iron content reported is 15.50 ppm. and the minimum is 0.15 ppm. For the finished water, the maximum iron content is 1.32 ppm. with a minimum of 0.00 ppm.

The U.S. Public Health Service inventory (1) lists 215 sources of supply in Louisiana, 187 of which (approximately 87 per cent) are wells. The Louisiana Dept. of Health reports 26 plants for the removal of both iron and carbon dioxide, 2 plants for carbon dioxide removal and 3 for iron removal only. Thus, there is a total of 31 treatment plants, the same number as in Arkansas, for iron or carbon dioxide removal from 16.6 per cent of the well supplies or 14.4 per cent of all sources. The iron content reported reached a maximum of 24.0 and a minimum of

0.38 ppm. for untreated water; the maximum for treated water was 5.0 and the minimum, 0.0 ppm.

Approximately 71 per cent of the sources of water supply in Oklahoma originates in wells. The U.S. Public Health Service inventory lists 338 sources, 238 being wells. Dott and Warkentin (*2*) state that "iron-bearing water is not very common in Oklahoma" and "the iron is easily removed from solution by aeration and will settle out in the process of purification." This view agrees with the general conception that iron and carbon dioxide have not been the cause of serious problems in Oklahoma. According to the state health department, there is apparently no plant now operating which was installed specifically for iron or carbon dioxide removal. Nevertheless, published analyses (*2*) indicate that iron and aluminum oxides vary from traces to highs of 43 and 129 ppm. Many wells have a content above 10 ppm., and one shallow well supply showing 1.3 to 2.6 ppm. is being sold for drinking, laundering and photographic purposes.

Out of a total of 906 supplies in Texas 716, or 79.1 per cent, are derived from wells (*1*). Detailed information on the status of the iron problem in Texas is not available, but, according to the state health department, quite a large number of supplies in the East Texas area are affected. The health department estimated in 1939 that there existed 100 public water supplies with an iron problem, only 20 of which were providing adequate treatment.

It would appear from the above facts that the iron removal problem is a major one in the four states of the Southwest Section, where wells are the principal source of supply and most waters contain iron in quantities substantially above the maximum permissible limit of 0.3 ppm.

Reasons for Removal

Industrial specifications are often more severe than the U.S. Public Health Service drinking water standards, which suggest that iron and manganese should together not exceed 0.3 ppm. Iron causes discoloration of pulp and paper in the paper industry and should not be greater than 0.1 ppm. for high-grade products. Manganese similarly discolors fiber and is detrimental to the stability of rosin sizes. It should not exceed 0.05 ppm. for high-grade products. A carbon dioxide content above 25 ppm. may seriously affect the sheet formation on the paper machine, and a maximum limit of 10 ppm. is probably desirable.

In the rayon industry, the iron content should be less than 0.1 and preferably below 0.05 ppm. Iron is responsible for spots and discoloration in tanning or processing hides and leather goods. In the distilling industry, the water must have complete clarity, palatability and freedom from iron and manganese. These are but a few of the many rigid demands made by industry which must be acknowledged and satisfied by producers of water, whether private or municipal.

The features of an iron-bearing water which normally make it objectionable for municipal use are the staining of plumbing fixtures and clothes; interference in culinary uses, such as causing tea to turn black and darkening vegetables cooked by boiling; promotion of iron bacteria in the mains with accompanying increases in friction loss and

power consumption; and precipitation of the iron to cause familiar red-water problems in the home and in industry. These are certainly justifications for the elimination of iron from water.

Occurrence of Iron

Iron is not uncommon in most water supplies, and it is found in its various combinations in both shallow wells and deep wells. Usually the iron appears to exist as the ferrous salt, probably the bicarbonate (3). Because iron occurs in nature most frequently as an oxide, it is worth while to note the relationship between this form and those found in water. Buswell (3) reports that:

> Since the oxides are exceedingly insoluble, they do not constitute an important source of iron in iron-bearing waters except as they are attacked by carbonic acid. The most common form of iron found in water is the ferrous carbonate. This compound, occurring as the mineral siderite, has a solubility of 65 ppm. Its solubility is greatly increased by the presence of carbonic acid (free CO_2). When hydrolyzed to ferrous hydroxide, it still is soluble to the extent of 7 ppm. This is in marked contrast with the ferric oxide or hydroxide, which is practically insoluble. Ferrous sulfide, FeS, is soluble to the extent of 6 ppm, and the pyrite, FeS_2, to the extent of 5 ppm. These solubility data on the various forms explain why the ferrous carbonate or bicarbonate is by far the most common compound found in so-called iron-bearing waters.

In addition to the ferrous bicarbonates in well waters with large amounts of free carbon dioxide, the ferrous sulfates are found in highly mineralized waters, and complex organic combinations are present when the source is in a swampy area.

Theory of Treatment

Most investigators classify the three general types of iron-bearing ground water: [1] waters in which the iron begins to precipitate immediately after aeration; [2] waters in which the iron is not easily precipitated by aeration (acid water); and [3] waters in which part of the iron precipitates readily but the remainder is held indefinitely. These are, of course, very general classifications, and there are other conditions which should not be overlooked.

A distinction must be made between the iron in the ground water and that picked up because of the corrosion of piping systems. Iron pickup can be controlled by treatment for the elimination of carbon dioxide or by the use of other anticorrosion methods involving pH adjustment. The removal of carbon dioxide by aeration involves an inherent increase in the dissolved-oxygen content of the water, and this increase is often great enough to cause corrosiveness. At the other extreme, the iron content might be due to old deposits which have become reduced and been dissolved in water low in oxygen and iron.

Because the problem of iron and carbon dioxide in water can be so confusing, the situation should be carefully analyzed before a treatment program is undertaken. Complete chemical analysis of the water is always a proper starting point, with tests for free carbon dioxide, pH and alkalinity being made immediately at the source. Frequently the proper method of treatment is not obvious and pilot plant studies are desirable to determine the basis for plant design.

Before discussing the various treatment methods briefly, it may be well to

mention two of the chemical reactions involved. The equation:

$$4Fe(HCO_3)_2 + O_2 + 2H_2O = 4Fe(OH)_3 \downarrow + 8CO_2$$

indicates that it requires about one part of oxygen to oxidize seven parts of iron, or approximately 0.14 ppm. of oxygen per part per million of iron present. A relatively small amount of oxygen is sufficient to cause the precipitation reaction. A detailed and theoretical discussion of this reaction is given by Buswell (3), who also points out that the equilibrium:

$$H_2O + CO_2 \leftrightharpoons H^+ + HCO_3^- \leftrightharpoons 2H^+ + CO_3^{--}$$

is of prime importance in water chemistry. Any factor which tends to displace this equilibrium may determine the course of the reactions involved in iron removal.

Research and practice have shown that the removal of carbon dioxide causes an increase in pH or a depression of the hydrogen ion concentration and thus favors the removal of the ferrous compounds. A similar reaction is caused by the addition of an alkali. Evidence of this fundamental reaction is always at hand—in the form of incrustations on hot-water systems where the carbon dioxide has been liberated by heat; incrustations of filter sand where the carbon dioxide was released by a reduction in pressure; or reduction in well yield due to incrustation caused by a high velocity of approach in the aquifer.

In the first reaction, it will be observed that aeration is almost a necessity in removing iron salts and it would not be practical to try to remove these compounds from water devoid of dissolved oxygen. There are always exceptions, such as extremely acid waters, but Baylis (4) notes that: "the water would have to have a pH less than 4 for iron to exist in the soluble state in the presence of dissolved oxygen." Another important factor, time, becomes involved. Baylis explains that:

> Immediate precipitation of the iron may not follow when dissolved oxygen is restored to the water by aeration, for, when the pH and the iron content are low, the formation of a precipitate is very slow. When the pH is below about 6, the formation of a precipitate is so slow, even when considerable iron is present, that it would not be completely removed in the usual treatment plant. One of the aids given to the precipitation of iron by aeration is the increase in pH resulting from lowering the CO_2 content.

Numerous other factors may enter into the treatment of water for the removal of iron and carbon dioxide, some of which will be discussed in conjunction with the various treatments.

Removal Processes

Iron and carbon dioxide removal processes may be divided into eight major classifications (5):

1. Aeration
2. Aeration—settling—filtration
   - *a.* At atmospheric pressure
   - *b.* Under main pressures
3. Coagulation—settling
   - *a.* Without filters
   - *b.* Followed by filtration
4. Use of contact filters
   - *a.* With aeration
   - *b.* Without aeration
5. Use of special minerals and ores
6. Nonatmospheric oxidation
7. Removal incident to softening
   - *a.* Cation exchange
   - *b.* Lime
8. Stabilization or sequestration

As previously stated, approximately 0.14 ppm. of oxygen is required to oxidize 1.0 ppm. of ferrous iron. The oxygen for this purpose can be provided by various types of aerators. The open type, which is commonly employed, may consist of spray nozzles, coke trays, rotary distributors or perforated pipe. Use is sometimes made of forced-draft aerators, which bubble compressed air through a water tank.

Efficiencies will vary with the surface area of the water in contact with air (4). In the spray or the bubble type of aeration, the drops or bubbles should be as small as possible. The water which trickles over coke trays is constantly forming new surface films. The rotary aerator has proved to be very effective, inasmuch as the water is transformed initially into thin films by splash plates and then has a free fall before being distributed over wood slats or coke trays. This repeated formation of a thin film is to be desired.

During aeration carbon dioxide is released, raising the pH and promoting the precipitation of the basic carbonate or oxide. The percentage reduction in the carbon dioxide content is generally lower when the initial content is low. Open aeration cannot be expected to remove all the free carbon dioxide, and the reduction is less with highly alkaline or highly buffered waters.

Settling has been considered following aeration, but it does not add greatly to the effectiveness of iron removal unless large quantities of iron are present. In addition to the precipitate, a rather stable sol is formed which does not settle well and gives a rather opalescent appearance to the water. To remove the iron in this condition, it becomes necessary to apply filtration. Either gravity or pressure filters may be employed, but the inherent advantages and disadvantages of each should be considered during the design period.

Coagulation, followed by settling and possibly filtration, is used to hasten the sedimentation process. Without the addition of coagulants, the oxidized iron may take 12–24 hours or more for effective settling, whereas properly coagulated water will normally allow sedimentation to take place in approximately two hours. Rapid-rate slurry units may decrease even this period.

Contact filters have many advantages and numerous installations of this type have been found economically justified. It is possible to combine contact filtration with one or more of the other fundamental processes and design an effective and economical treatment plant. Open aeration is accomplished during the distribution of the water over the contact medium, and aeration continues with the flow through the medium as the water forms thin, constantly changing films and drops. The medium, composed of anthracite, coke, marble, limestone or gravel, becomes coated with the oxides, which aid in promoting further and more rapid oxidation of the influent. It should be noted that the beneficial catalytic effects of previously formed iron oxide coatings are also present when coke tray or other types of aerators are used, but not to the extent found in contact filters.

By utilizing a fine medium, a large amount of surface area is provided and there is sufficient void space to accumulate the oxidized iron. One advantage of the contact filter is that it can be backwashed to remove the excess accumulation, leaving the filter in condition for another cycle. Because of the rather gelatinous nature of the oxide and the fineness of the medium, the contact filter strains out not only the

iron compounds but also other solids suspended in the water. Thus, a sedimentation tank or sand filter can usually be eliminated.

The Ferrofilter * unit combines a $\frac{3}{32} \times \frac{3}{16}$-in. medium, which backwashes easily, with a rotary distributor to apply the water properly to the medium in thin films. By the use of a tank, forced ventilation is possible to insure proper oxidation and scavenging of the carbon dioxide from the filter. This type of treatment has produced iron residuals ranging from practically zero to 0.3 ppm. State health department reports show a final effluent iron content of 0.01 ppm. at Fisher, Ill., where the designed surface rate of the filter unit was 6.2 gpm. per square foot. In a water containing 4.0–7.0 ppm. iron and 334 ppm. alkalinity at Hartford City, Ind., the iron was reduced to 0.2 ppm. A Mississippi plant, designed for 1,500 gpm. and a surface rate of 7.5 gpm. per square foot, has reported iron reduction from 18–20 ppm. to a trace. The raw water not only is high in iron but has a carbon dioxide content of approximately 95 ppm. and a pH of 6.4. The carbon dioxide content of the effluent is about 33 ppm. and the pH is 6.8–7.1. Similar units are operating successfully in Arkansas, Louisiana and Texas.

Special minerals utilized as aids in iron removal include pyrolusite, manganese-coated sand and commercially coated material such as "Birm." † Normally, however, the filter medium becomes coated during operation and is equally as effective as the precoated media.

* A trade name of The American Well Works, Aurora, Ill.

† A trade name of Research Products, Inc., Madison, Wis.

Occasionally it may be found advantageous to resort to a means of oxidation other than atmospheric aeration. Ozone and potassium permanganate may be used, although chlorine is, of course, the most common agent. Chlorine will oxidize iron at a relatively low pH. If the iron is bound in an organic complex, the chlorine will first destroy the compound, so that the iron can then be more readily oxidized. Chlorine is also used to reactivate the deposits in contact filters in order to bring the filter up to maximum efficiency.

Iron and carbon dioxide can also be removed incidental to lime or cation-exchange softening. In the former, the lime hydrate reacts with the carbon dioxide present, although it is more economical first to reduce the carbon dioxide by aeration. Iron precipitates as the hydrate, particularly at the higher pH values, a pH above 8.5 being most effective.

Zeolite softeners always remove some iron. A manganous zeolite, which is recharged with potassium permanganate, is well known for its ability to remove iron. The newer types of organic cation exchangers, which can be regenerated with either sodium chloride or dilute acid, have shown greatly increased capacity and are being widely used, particularly in industry.

When a well water has a relatively low iron content, the removal of the iron may not be necessary and it can be sequestered or held in solution by the use of a phosphate.

Summary

In Arkansas, Louisiana, Oklahoma and Texas, more than 77 per cent of the water supplies are derived from wells. Analyses and other data indicate that this well water generally has a high iron content and the problem of

its removal will become more and more apparent.

Iron commonly exists in water as ferrous carbonate or bicarbonate, along with free carbon dioxide, which attacks the iron in the ground and places and maintains it in solution. The iron may be in other, more complex combinations and in a form more resistant to treatment.

Treatment may follow any one or more of eight methods listed, aeration and aeration in combination with a contact filter being quite common and effective. Coagulation, settling and filtration are valuable methods for particular waters. Other proved methods are removal incident to softening, and stabilization with chemicals.

Acknowledgment

The author wishes to express his appreciation to the chief sanitary engineers of the state health departments in the Southwest for the information which they supplied.

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New Dating System for Specifications

In order to indicate as clearly as possible how recently any given specification has been revised or reviewed, it has been decided to incorporate the year of the latest revision in the code designation of the specification itself. This date will then replace the date currently used, which is the year the document was adopted as Standard. The following four documents have been revised since their adoption as Standard and are therefore affected by the change in policy:

Old Designation	*New Designation*
7D.2–1947	7D.2–1948
7A.3–1940	7A.3–1949
7A.5–1940	7A.5–1949
7A.6–1940	7A.6–1949

No change has been made in the text of these specifications since the year shown in the new designation, and existing stocks imprinted with the old designations will continue to be used until exhausted.

In addition to changing the designation of a specification of Standard status each time it is revised, the year of tentative approval will be added to the designation of all specifications of Tentative status. Thus, the document now called "7D.1–T" will be known as "7D.1–T–1949." As in the past, when such Tentative documents are reviewed and advanced to Standard, the "T" will be dropped and the year of approval as Standard will be included in the designation.

Amherst Water System

By V. G. Fuller

A paper presented on Oct. 24, 1949, at the Maritime Water Works Assn. Meeting, Amherst, N.S., by V. G. Fuller, Secretary, Water Commission, Amherst, N.S.

AMHERST, N.S., is in many ways like scores of other towns in the Maritime Provinces. Sixty years ago it was an optimistic village of about 3,000 population which desired to become incorporated as a town. During the first year of incorporation, 1890, a resolution was passed by the town council to bring in an engineer from Ontario to make an estimate of the cost of a municipal water supply system. Town records do not show what became of this engineer or his survey, but in 1891 a Boston engineer named Dodwell designed the present system. After much controversy, the source of supply decided on in 1891 was the Nappan River, which contained an abundant quantity of highly colored water.

The Nappan River basin, which holds approximately 65 mil.gal. (Imp.), is about 5 miles from Amherst, in the beautiful Brookdale Valley. When the system was constructed, the water was conducted by a 10-in. line from Brookdale to the Willow Street reservoir, with a storage capacity of 1.45 mil.gal. (Imp.). From the reservoir, 10- and 12-in. mains, branching as required, brought the water to the consumers. As high land intervened between Brookdale Valley and Amherst, pumping facilities were necessary. The steam boiler and pump originally installed were replaced in 1935 with an electric pumping unit and an auxiliary gasoline engine. This system served Amherst from 1891 until 1944, while the town population increased from 3,000 to 12,000.

Until 1944, whenever John Jones was taking a bath upstairs, his wife could not wash the dishes downstairs. When Bill Smith next door decided to wash his car on Monday morning, Mrs. Brown could not do her weekly laundry, because the pressure was too low to supply the demand. When the fire department received a call three blocks off the main line, it depended on chemicals and the Good Lord to save the property.

In 1942, when the author was appointed town auditor, the water system was operated by a committee of the town council. An audit disclosed that the sum of $25,000 was listed as annual revenue from what was termed the "water tax." As this appeared to be a round number and examination showed that in previous years the books had carried a like amount, the author decided it should be verified. It was found that this figure represented cash actually paid into the town office within the year for water services. It had no relationship to the number of services being supplied or to any annual rate structure. In fact, this money consisted of yearly contributions to the town by about 1,200 of the 1,900 consumers who were later discovered to exist. An examination of the so-called water ledger in 1942 revealed that it had not been posted,

nor had a single entry been made in it, since 1936. No water accounts receivable were listed as assets, and no attempt was being made to collect the water tax from those who did not care to pay.

The author found a flat annual item of $15,000 listed as the cost of operating the water system. This figure had been arrived at by a council estimate of what it thought was a fair proportion to charge up to the water department. By this method of accounting, there was an annual profit of $10,000 on the sale of water. This amount showed up clearly each year as a surplus and was taken into consideration by the council in fixing the annual tax rate. During the twenty years or more in which this situation had existed, the taxpayers of Amherst received the benefit of $200,000 in "profits" from the sale of water in the form of tax reductions.

A house-to-house survey showed that, instead of 1,200 consumers, there were actually 1,900. In other words, 700 people or business firms connected to the system had never paid a cent for water and had never received a bill. Thus, the revenue under the rates existing at that time should have been $38,000 a year instead of $25,000. The actual annual cost of operating the system had lost $9,000 annually for the twenty years under review, or system had been losing $9,000 annually for the twenty years under review, or $180,000. To this loss must be added the $200,000 taken in tax reductions on the basis of a surplus which did not exist. In view of the six-year statute of limitations, only $24,000 in back rates was recovered.

In 1942 the Nappan River dam, pumping station, reservoir and feeder main to the town were all 51 years old. Little or no major repairs had ever been made, nor had one cent been allowed for depreciation. At the end of 1943 the people of Amherst realized for the first time that they owned a water system, that it cost money to operate and that they, the people, must pay for the water consumed. The public started to demand something for its money. Amherst had inadequate fire protection, and its water was a dirty color, being unfit for drinking at some seasons of the year. At other times the supply was so low that the public had to refrain from washing cars and the like.

The town council decided to accept the theory that selling water on a rate basis was strictly a business proposition, in no way connected with taxation, and that it should be separated as far as possible from the general town business.

It was realized that, for the system to survive, it must have continuity of management. Therefore, in 1945 a bill passed the Nova Scotia legislature setting up the "Amherst Water Commission," a body corporate, whose membership consists of the mayor, one councilor and three citizens appointed by the council for staggered three-year terms, so that the commission is always assured of at least three continuing members.

A further step was to establish an adequate accounting system, including a more complete consumer survey and an exhaustive examination of the capital structure of the system. Coupled with these items was a complete engineering survey of the requirements which must be met not only to place the system in a safe position to supply the public demand and fire protection needs, but to allow for normal growth as well.

The latter survey resulted in a five-year program of rehabilitation, four years of which have now been com-

pleted. This program included two additional 10-in. feeder mains to the town, so located and designed that, when they were tied in with the existing central feeder mains, they provided a complete outside feeder supply of a circulating nature. Next cross lines were extended and dead-end lines entirely eliminated. Today Amherst can boast of a nearly 100 per cent circulating system. These improvements brought the fire protection pressure up to the required figure, 60 psi., with a domestic pressure better than 45 psi. The system contains 26 miles of 4–12-in. pipe, which now serves 1,670 domestic and 246 industrial connections. A total of 189 hydrants offers adequate fire protection to the town.

In 1942 it was found that the color in Amherst's water was due to a sediment that would not allow the operation of a ¾–3-in. meter for more than one to three months. After that the meter would be entirely stopped and its working parts so badly corroded that they had to be completely renewed. Furthermore, consumers were required to take down and clean their hot-water tanks at least once every two years; otherwise, their supply of hot water was absolutely cut off.

The two possible solutions were a filter plant costing an estimated $200,000, with a probable annual operating expenditure of $10,000, or a new supply of water, which could only be obtained from artesian wells at an unknown cost. As artesian wells seemed to be the popular choice an application was made to the board of public utilities for permission to bore for water, but the board decided that it could not authorize such a gamble with the people's money until a geologist's report was secured. The gist of his report was that, if Amherst were located in the Sahara Desert, it would not be in a less likely place to strike water.

Plans and specifications for a filter plant were drawn up and approved, but, before construction was begun, a final appeal was made to the board of public utilities for permission to bore a 6-in. hole, at a maximum cost of $3,000, merely as an experiment. The board agreed, and the test proved successful. Of seven borings to date, five have been producers, and Amherst can be supplied with more than 1 mil.gal. (Imp.) of pure artesian water daily should it be required. The total expense will not exceed $45,000, a considerable saving over the estimated $200,000 cost of a filter plant.

Thus, four years of the five-year program have been completed and only the metering of consumer services remains to be carried out. Whether this result could have been accomplished under council committee management is a matter of opinion, but the fact is that it *was* accomplished in less than five years of commission management.

In 1948 the revenue from the sale of water in Amherst exceeded $54,000, compared with $25,000 in 1944. A $38,000 cash depreciation reserve, invested and earning 3 per cent or better in 1948, was available for future replacements to capital assets in plant and equipment, as against nothing in 1944. In 1945–48 Amherst received $8,200 annually in direct taxation from the water commission, and in each of these years the commission showed a net surplus of more than $3,000 after providing for all capital debt charges, taxes and depreciation reserve.

The Amherst water system has progressed from an almost ignored service to an indispensable one, from a losing, deteriorating investment to a profitable, serviceable public utility.

Special Service Charges

By D. M. Williams

A paper presented on Nov. 7, 1949, at the North Carolina Section Meeting, Southern Pines, N.C., by D. M. Williams, Supt., Water & Sewer Dept., Durham, N.C.

THE chief worry of municipal officials is finding new sources of revenue to overcome the extremely rapid increase in the cost of operation and expansion. Some municipalities which formerly owned their power utilities, as well as their water and sewer systems, gave so much free service that when an offer was made to purchase the utility, they sold it. They had neglected to charge for lighting streets and public buildings and sometimes for pumping water. Of course, it was necessary for these towns to pay the private utility which purchased their plants for the services previously unbilled. Usually they were shocked to find that they had sold the goose that laid the golden eggs.

Prior to 1916 the water works in Durham was owned by a New England corporation whose officials were aware of the losses in revenue which result when only the water consumed is charged for. This utility even collected meter rent where there were no meters. There was a charge to the city for each fire hydrant located on the street. All concerns having sprinkler systems paid standby fire protection charges, and those with private hydrants on their property paid for fire protection on an annual hydrant basis. There was no free service. The customers paid for the cost of making the water connection, installing the meter and carrying the connection to the property line. All of the charges except that for absent meters were continued by the municipality after it took over the water works.

During the late 1930's the Durham Water Dept. absorbed the cost of maintaining and operating the sewage disposal plants, and a few years later the sewage system operating cost was also absorbed by the water department, including the maintenance of all sewage connections from the mains to the property line.

Sewer Charge

By 1947 it was found that the water department revenues were insufficient to meet all of the costs of water and sewage operation and maintenance in addition to financing the expansion of both systems. The first thought was to increase the rates for water, but, before doing so, a comparison was made with the rates in a number of large towns. This investigation showed that some towns were virtually giving their water away to the large customers. Moreover, those cities having the lowest rates were furnishing water to large textile mills which were competitors of Durham's. The local mills bitterly protested any increase in the water rates and pointed out how much they could

save if they obtained their water at the same rate as some of their competitors pay.

Durham next considered the matter of a sewer charge and found that its industries did not have the same objection to paying such a charge, based on a percentage of the water bill, as they did to a straight water rate increase. Effective July 1, 1948, the city levied a sewer charge equal to 25 per cent of the water bill for users inside the city limits, with a maximum of $100 per month for each customer. The yield is a little over $100,000 annually.

Revenue Collected

For more than twenty years Durham has been charging $15.00 per residence outside the city limits where the sewage is handled by the city's system. Durham charges double for water and fire protection to customers outside the city limits. In 1948 the city collected $62,600 for water sold to such customers, or $31,300 more than the inside-city rate would have yielded.

In 1948 water sold to the city for purposes other than schools yielded $6,400 (the income from schools is not broken down). Fire hydrants on the city streets at $30 each brought in $32,400. The revenue from fire protection for industries amounted to $22,600. (This figure would have been $4,550 less if the regular inside rate had applied to the outside private hydrants.) Finally, the boating and fishing revenue was $9,256, making a total of $101,956 for what might be called "extra services," over and above the sale of water and the sewer rentals.

Durham charges $50 for tapping the main and laying the ¾-in. service, including the meter, to the property line. For a 1-in. service and meter the charge is $83.00. Bills for larger connections are based on cost. These charges alone brought in $34,300 during the year. The revenue from a $75 charge for making a 4-in. sewer connection from the main to the property line was $21,410.

It is obvious that the water and sewer utilities, like others, have sources of extra revenue, and Durham is not overlooking them.

Wage Levels and Job Classifications for Municipal Water Works Employees

By Robert M. Dixon

A paper presented on Oct. 11, 1949, at the Southwest Section Meeting, Oklahoma City, Okla., by Robert M. Dixon, Mng. Director, Munic. Contractors Assn., Dallas, Tex.

A FAIR wage in the water works industry may be defined as that which is in effect in a particular community for similar jobs with like duties and responsibilities. Because this definition leaves unanswered the question of whether the community wage level is right or wrong, a comparison of the compensation for like work in communities of like size can be helpful. Economic and climatic conditions may differ widely, however, and special conditions may influence local wage rates, making them a matter for individual consideration.

It is possible for the price tag on a job to be regarded as too low by the worker and, at the same time, as too high by the employer, but this situation also applies to commodity prices fluctuating in a free market, the plateaus of which are never satisfactory to the buyer and the seller simultaneously. In a free economy, costs, prices and wages are tied rather closely together, and any increase or decrease in one will normally be reflected in the others in due course. The wage earner's cost of living goes up because the prices of the things he has to buy go up, which brings on a demand for cost-of-living raises. Increased wages, in turn, force the cost of production up, and the worker is soon back where he started and is ready for a new wage increase. But there must be a limit to this process or the employer will be priced out of the market, either because his competitors can sell more cheaply or because the public refuses to buy and is willing to accept a substitute product instead of continuing to purchase the higher-priced one. If this attitude spreads, the volume of sales and, hence, the income of the wage earner's employer shrink, which means less money available to pay higher wages. In addition, the lower sales volume may result in higher unit production costs, aggravating the condition further. As more industries become affected and a great many people find themselves out of the market, the situation deteriorates into what is called a depression.

In the past economists spoke of business going through "cycles" of good times and bad, with the relationship between supply and demand determining the price levels. But that was before the country entered the current period of economic stabilization by government control. At present the law of supply and demand does not operate freely because of such artificial factors as price subsidies, produc-

tion controls and the establishment of arbitrary wage levels by governmental or labor union action.

A good illustration of the latter exists in the building trades, where, as a result of high hourly rates maintained by union pressure, a craftsman's average yearly earnings may actually be less than they would have been with lower wages and a greater market for his services. Furthermore, the supply of skilled workers is limited by union restrictions on apprentice training. For example, a shortage of bricklayers cannot easily be overcome, even though finished bracklayers can be trained in only a few months' time. As long as these conditions are permitted by the government, higher prices for labor will be the order of the day, and the result will be higher costs for houses for water works employees—to say nothing of the increased costs of the materials and supplies which the water superintendent must buy to keep the department going.

Desire for Security

The building trades unions are by no means alone in exercising such pressure. The new labor philosophy seems to be to get as much as possible while the wheels are turning and, when they stop, to trust to luck or live off the government-provided unemployment compensation which was collected from the employer in the days when he could afford to operate. A "benevolent" government has imbued the people of this land with the idea of security, but whether the economy can be stepped up to and maintained at the throbbing pace necessary to make good on the government's promises without breaking down is questionable.

Agitation for a higher and higher standard of living for the worker is reportedly the chief business of the labor unions, but this, in turn, necessitates organization for protection on the part of the employer who finds labor hemming him in on one side and regulations, laws and edicts closing in on the other, while he must face existence in an economy only partially free. To paraphrase Lincoln, one may wonder how long this economy can exist "half slave and half free."

Political promises of security for the worker through government largess are weakening character and integrity by encouraging a lack of planning for the future and by stunting ambition to get ahead. Applicants for jobs today are interested first in whether they get Saturday off; next, in how long the vacation is; third, in whether sick leave and pensions are provided; and, finally, in what the salary is. According to a recently published nationwide survey, only in Texas and Oklahoma were college students generally putting job opportunity above security. Such a security-minded attitude is not good for a vigorous America, but it has been brought about by political action, which is increasing in popularity with each passing year. The question is how long this trend can continue when the security promised to one class is being taken from others. Nowhere do the politicians approach statesmanship near enough even to suggest cooperative economic security. Instead, they preach the doctrine of security through subsidies provided by taxation, a doctrine which has been well established and widely accepted.

Effect on Public Employees

Although all federal labor laws which regulate the number of hours and the length of the work week specifically

exempt the employees of political subdivisions, the application of those laws to industry exerts an indirect effect on public payrolls in the long run. Because the source of new labor is common to both private and public employers, the job that is most attractive in terms of wages and working conditions will have first call on the market. The higher labor costs which result from maintaining a favorable position in the labor market are reflected in the prices to the consumer. Because of the necessity for competing in the labore market, "security thinking" very seriously affects every public payroll in the country.

With these points in mind, it was decided to survey all cities in the Southwest (Texas, Oklahoma, Arkansas and Louisiana) with populations greater than 10,000, in order to learn whether certain trends in wage patterns were showing up, what the general wage levels were and how municipal pay scales compared with those of privately owned utilities. The survey indicated that the backwash from industry's wage patterns was affecting municipal payrolls. The eight-hour day, 40-hour week which is generally standard in industry is beginning to appear in municipal water departments where competition for labor exists. Paid vacations were well established in almost all municipalities replying, and retirement and pension plans can be expected to grow in number, following the pattern of private industry. As social security taxes increase, the cost of these pensions will decrease for the private employer, but this will not hold true for public payrolls.

As shown by Tables 1 and 2, municipal water department employees have been given wage increases in keeping with the rise in the Bureau of Labor Statistics Consumer's Index. There seems to be a great difference in pay levels for similar jobs in communities of similar size, however, which can probably be traced to the fact that this

TABLE 1

Wages of Municipally Owned Water Works Employees, 1949

Classification	Population of City								
	over 100,000			25,000–100,000			10,000–25,000		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
	Monthly Rate—$								
Superintendents	495	800	550	280	550	396	200	335	291
Cashiers	182	260	135	130	245	177	150	194	169
Junior stenographers	180	235	150	145	155	151	115	170	153
Storekeepers	186	259	235	175	247	225	100	200	165
Meter readers	170	242	175	140	230	198	140	212	174
Meter repairmen	175	242	190	150	222	196	100	200	157
Light-truck drivers	161	228	194	130	192	166	124	185	158
Laborers (*hourly rate*)	0.70	1.00	0.85	0.50	0.96	0.77	0.45	0.77	0.66

industry is operating on a job title basis rather than on a system of job classifications based on duties and responsibilities. Where that is true, it goes without saying that two jobs cannot be compared unless everything is known about both of them.

Survey forms were submitted to privately owned utility companies, many of whom responded admirably. It was for this cooperative effort that the job classifications used in the tables were selected, but the training policies in effect in some of the privately owned utilities tend to offset the comparative value of the figures submitted. For instance, electric-meter repairmen are often young college students who will be kept on their present jobs only for a training period. During that time, however, they may be paid as junior engineers instead of as repairmen. For this reason, the salary schedules of such utilities are not tabulated, but it can be said that personal interviews with the managers give reason to believe that water works employees in the Southwest are in a favorable pay position with respect to their monthly take-home pay, even if they are required to work an average of 44–48 hours per week, as compared with 40 hours for the private utility employee. On an hourly basis, the pay scales are very close together—as far as can be determined without job descriptions on which to make wage comparisons.

Job Classification Program

If a job description and classification program is decided upon—and it is strongly recommended as a control measure, in addition to providing information for personnel purposes—assistance can be had from prepared texts and magazine articles, any number of which have been written and printed in management periodicals. (A suggested classification system is given in the appendix to this paper.) Job sheets will necessarily have to be prepared locally to fit local conditions, and the sooner the start is made, the sooner results will begin to show up. Obviously, the need exists, and, judging from the benefits that have accrued to industry as a result of job classification programs established, they can be recommended to municipal water works superintendents and managers without reservation. A job classification program makes it possible to determine wage scales commensurate with responsibilities and comparable to those for similar positions in private industry. It also helps, when necessary, to show the public the need for increasing the wages paid to municipal employees. Low wages do not attract quality employees unless other advantages outweigh them, which is not normally true for public employment in general.

TABLE 2

*Relative Pay Rates, 1949**

Classification	Population of City		
	over 100,000	25,000–100,000	10,000–25,000
	Index (1942 = 100)		
Superintendents	1.33	1.44	1.43
Cashiers	1.80	1.50	1.32
Junior stenographers	1.30	1.45	1.80
Storekeepers	1.67	1.64	1.40
Meter readers	1.13	1.42	1.55
Meter repairmen	2.04	1.67	1.45
Light-truck drivers	1.70	1.53	1.52
Laborers	1.88	1.57	1.66
Avg.	1.58	1.49	1.45

* The relative value of the U.S. Bureau of Labor Statistics Consumer's Index in 1949 was 1.46 (1942 = 100).

It has been said that no job classification procedure can be as satisfactory as the classification methods used in the physical and biological sciences, because, in classifying jobs, the analyst must deal with the human element. Nevertheless, job classification is a move in the right direction and deserves a trial. It is also quite effective in stabilizing wage and salary rates, because the price tag is on the job and not on the person, and demands for more money are limited by the brackets set up for the job.

Labor organizers are constantly looking for new fields, and their only real excuse for existence is to obtain higher pay and better working conditions for the union members. If the employee feels that he is not being properly compensated for his efforts, the promises of the labor organizer are likely to be more appealing than if fair wages were being paid and working conditions established which were comparable with those provided by other employers. Job classification will not, however, be a panacea for labor troubles, because this procedure does not guarantee against poor organization, poor administration, bad supervision, inefficient workers and political interference. Classification is nothing more than a management operating tool which can be of great benefit if properly used. Any wage program based on job classification should be administered largely by the water department rather than by some other authority which may not be too concerned with worker-supervisor relationships. Unless the former is true, harm as well as good can come from such a system.

As functions and responsibilities change, job sheets must likewise change, if they are to be kept up to date. When technical developments and reorganizations within the department affect duties and responsibilities, the value of and the wages for the job should be adjusted, because wage levels and worker morale are rather closely associated.

The relationship between wages, prices and costs does not remain the same for long periods of time, but the industry's prestige is at stake and it cannot be advanced unless high-grade employees are attracted to water works jobs. In order to attract them, the municipal water department superintendent needs to be in a position to present his case to the governing body frankly and conclusively, and to back up his arguments about personnel with facts and figures. Industry is his competitor and, since the rivalry is great, he will need all the help that facts and figures can provide.

APPENDIX

Job Classifications

Below is a suggested list of job titles for water works properties. These classifications were used as the basis for an inventory of industry personnel in 1948.

1. Supervisory Staff Group

a. Manager or superintendent
b. Chief engineer
c. Assistant manager or superintendent
d. Assistant chief engineer
e. Unclassified

2. Production Group (Pumping Stations and Collection Facilities)

a. Production engineer or superintendent
b. Assistant production engineer or superintendent
c. Operator

2. Production Group (contd.)

d. Fireman
e. Maintenance man
f. Machinist
g. Electrician
h. Boiler repairman
i. Relief man
j. Oiler
k. Coal passer
l. Plant laborer
m. Unclassified

3. Purification Group

a. Purification engineer or superintendent
b. Assistant purification engineer or superintendent
c. Chemist
d. Bacteriologist
e. Plant operator
f. Laboratory assistant
g. Relief man
h. Purification laborer
i. Unclassified

4. Distribution Group

a. Distribution system engineer or superintendent
b. Assistant distribution system engineer or superintendent
c. General foreman
d. Foreman
e. Emergency repair crew foreman
f. Storekeeper
g. Auto mechanic
h. Emergency repair crew man
i. Reservoir man
j. Distribution system clerk
k. Distribution system laborer
l. Unclassified

5. Outside Commercial Group

a. Meter reader
b. Collector
c. On and off man (inspector)
d. Unclassified

6. Meter Shop Group

a. Foreman
b. Meter repairman
c. Meter shop laborer
d. Unclassified

7. Office and Interior Commercial Group

a. Cashier or accountant
b. Assistant cashier or accountant
c. Office manager
d. Clerk—senior
e. Clerk—junior
f. Secretary
g. Stenographer
h. Teller
i. Billing-machine operator
j. Telephone operator
k. File clerk
l. Addressograph operator
m. Typist
n. Office boy
o. Porter
p. Janitor
q. Unclassified

8. Plant Property and Protection Group

a. Guard or watchman
b. Caretaker
c. Unclassified

9. Miscellaneous Group

a. Temporary skilled laborer
b. Temporary special clerk
c. Temporary semiskilled laborer
d. Coal unloader (temporary)
e. Temporary unskilled laborer
f. Unclassified

Legal Aspects of Transmountain Diversion in Colorado

By Jean S. Breitenstein

A paper presented on Sept. 22, 1949, at the Rocky Mountain Section Meeting, Colorado Springs, Colo., by Jean S. Breitenstein, Atty., Denver, Colo.

IN all those sections of the West where rainfall is limited, the problem of water supply presents many bothersome complications. Because of geographical conditions, there are unusual situations in Colorado which plague the engineers and planners in their quest for an adequate municipal water supply. The scarcity of water on the eastern slope of the Rockies, where about three-fourths of the Colorado population lives, has forced the water departments of the state's major cities to look to the more abundant supplies of the western slope.

When water is taken from one river basin to another, many legal and political questions arise which must be answered. The legal aspects of transmountain diversion are a most comprehensive topic, and this paper can do no more than scratch the surface.

Transmountain diversions now under consideration are vast projects involving hundreds of thousands of acre-feet of water and hundreds of millions of dollars. The less difficult projects were all constructed many years ago. The Colorado–Big Thompson project, which will bring an estimated 300,000 acre-ft. of water annually through the mountains at a construction cost of about $145,000,000, will furnish supplemental water to more than 600,000 acres of land in northeastern Colorado and will increase the municipal supplies in that area. Under investigation are the Blue River–South Platte and the Gunnison-Arkansas projects, which may supply Colorado Springs, Pueblo and Denver with needed additions.

A municipality obtains water by appropriation, purchase or condemnation. Although the state constitution provides that domestic use is a preferred use, this statement does not mean that a municipality can obtain by appropriation priorities senior to the perfected rights for other uses. The effect of the constitutional provision is to give a city the power to condemn a right for a less preferred use upon the payment of compensation therefor.

On the east slope in Colorado, unappropriated water flows in the streams only in times of extreme floods. The purchase of irrigation rights from east slope streams is extremely expensive, and the necessary court order for a change in the point of diversion is often difficult, if not impossible, to obtain. In some of the larger towns, the topographical and climatic conditions are such that an adequate supply cannot be secured by the purchase or condemnation of existing rights.

The Colorado River Basin lies within seven states and two nations, with 64 per cent of the water in the stream at the international boundary coming

from the state of Colorado. Controversies over the right to use Colorado River water are of long standing. In 1922 an interstate compact made a division between the upper and lower basins. In 1945 the U.S. Senate ratified a treaty with Mexico which defined the share of that nation, and in the spring of 1949 final approval was given to a compact which divided the upper-basin share among the states of that area. As a result, Colorado is entitled to consume approximately 3,850,000 acre-ft. annually. Present consumption has reached 1,000,000 acre-ft.

West Slope Protection

The first problem presented in connection with the transmountain diversion of Colorado River water is as much political as it is legal. The west slope people rightfully are most zealous in protecting their interests. They desire the water to be used within the natural basin of the stream, if possible. The Colorado–Big Thompson project was not authorized until representatives of the two slopes entered into an agreement designed to protect the west slope by requiring the construction of a replacement reservoir on the Blue River to assure the maintenance of stated flows at lower river points. That reservoir, known as Green Mountain Reservoir, has the function, under the agreement, of furnishing water not only for existing uses but for all potential consumptive uses within the natural basin in Colorado.

A statutory protection for the west slope, contained in the 1943 amendment to the Water Conservancy District Act, states that no district organized under the act shall export water from the natural basin of the Colorado River without furnishing facilities to protect existing appropriations and "prospective uses of water for irrigation and other beneficial consumptive use purposes." This law applies only to water conservancy districts and not to transmountain diversions by other agencies. Since any diversion for the purpose of exportation to the east slope must take its place in the priority schedule, however, it would seem that those planning such projects must give consideration to replacement in times of low downstream flows so that the diversion for exportation will not be shut down under the operation of the priority system. For example, Denver has constructed a reservoir for this purpose on the Williams Fork.

The west slope people appreciate the protection which has been afforded them but claim that it is impossible to determine the amount of storage necessary to provide for their future use without further investigation of potentialities. They point to the great difference between the amount of money which the U.S. Bureau of Reclamation has spent on the investigation of transmountain diversion projects and that spent on the study of projects within the natural basin. In making such a complaint, they are on firm ground. A great deal more investigational work is needed on the west slope. To aid in carrying on these studies, an additional sum of $500,000 was appropriated by Congress in 1949 for upper Colorado River investigations.

To correlate the activities on the two slopes and to secure the maximum cooperation in the development of Colorado River water, the Colorado Water Conservation Board many months ago set up what is known as the Policy and Review Committee, composed of

representatives of the board, the Bureau of Reclamation and the east and west slope inhabitants. This committee has held several meetings and given those interested an opportunity to present their views.

Bureau of Reclamation

Turning from the political phases of transmountain diversions, one finds that there are many other serious problems. Shall a city construct a transmountain diversion project by itself or shall it participate in a Bureau of Reclamation program? If the city itself acts, it is not under the obligation to construct replacement or compensatory storage facilities, but its appropriative rights will have to take their proper place in the priority schedules and will be subject to shutoff orders when the stream flow is insufficient to satisfy all senior demands. The cost per acre-foot might be less if the city participates in a large Bureau of Reclamation project than if the city builds a smaller one with its own resources, but that is an engineering rather than a legal problem. If the city chooses to work through a federal project, it should be remembered that, before the secretary of the interior can enter into a contract to furnish municipal water, he must find that such use is not detrimental to the irrigation aspects of the project.

The generation of hydroelectric power enters into many transmountain diversions. Indeed, the need for power at reasonable and fair rates is secondary only to the need for water. It may be that a city acting alone can secure a multipurpose project from which both water and power can be obtained. Again, the best plan may be for the city to cooperate with the bureau and take advantage of the use of power revenues to defray part of the construction costs.

In this connection, a recent development should be mentioned. There are many good reservoir and power sites along the Colorado River and its tributaries. The Salt Lake City office of the Bureau of Reclamation has prepared a preliminary report known as "The Colorado River Storage Project." It is proposed that revenues from hydroelectric power generation at such reservoirs be used to help finance other water projects. The proper allocation of these power revenues among the upper basin states is a matter of high importance. In Colorado, there is the further problem of whether or not Colorado's share of such power revenues may be used both on in-basin and out-basin projects or only on in-basin projects.

If a city chooses to participate in a Bureau of Reclamation project, it must decide whether to contract directly with the bureau or to become part of a water conservancy district and contract with that. There are distinct advantages in the latter plan, which will be mentioned later. There are also some disadvantages, one of the most important of which is the requirement of the 1943 act that, if any curtailment of use in Colorado is necessary to satisfy the Lee Ferry delivery obligations of the 1922 compact, exportations shall be curtailed before there is any restriction on in-basin uses.

Water for Future Use

Inherent in any study of municipal water supply is the problem of assuring enough water to take care of the demands resulting from population growth. There is no provision under Colorado statutory law for the reserva-

tion of a block of water to meet future needs. According to the appropriation doctrine, the person who first applies water to a beneficial use has a prior right thereto. As application to use is an essential element of a valid appropriation, a city cannot file on water for use in future years and expect to have it available to satisfy an increased demand when it arises. In the meantime some other appropriator will have put the water to beneficial use and secured thereby a firm and incontestable right to it.

To get around the principle that one may not reserve water for future use, there has been conceived the device of disposition of currently excess water by sale or lease. By this means, a city sells or leases to farmers for irrigation purposes that portion of its water which is not needed for domestic use at the moment. Such a procedure involves distinct hazards and must be carefully planned if the desired results are to be obtained.

The question of the sale or lease of water for irrigation purposes by a municipality has been before the Colorado Supreme Court on several occasions. Based on its decisions, the following conclusions seem justified:

1. A city may sell or lease water covered by its appropriative rights under temporary contracts.

2. A city may obtain an appropriation decree, either absolute or conditional, covering water leased temporarily for agricultural purposes outside of the city area but served by the municipal water system.

3. It has not been clearly determined whether or not a city may obtain an appropriation based on beneficial use for irrigation purposes outside of the municipal water system.

A most formidable obstacle arises when a city desires to secure a water supply adequate to take care of the needs of an anticipated increase in population and yet cannot at the present time apply such water to beneficial use within the area served by the municipal water system. In such a situation, in order to put the water to beneficial use so that a decree of priority can be obtained, it would be necessary to employ the water on lands which are removed from and not served by the municipal system. The question then arises whether a carrier of water acquires any title in or right to the use, or control of the use, of the water carried. In a long series of cases, however, the court has held that the carrier acts only as the agent or trustee for the person who applies the water to beneficial use.

It seems clear that, in Colorado, the carrier does not have any true proprietary interest in the water. Accordingly, it must be recognized that, unless and until some constitutional statute is enacted to take care of this situation, a city cannot make a valid appropriation, which it can control as a proprietor, when the water is applied for irrigation outside of the area served by the municipal water system.

Utility Commission Jurisdiction

The sale or lease of surplus water by a municipality raises the question of whether or not such action would be that of a public utility subject to regulation and control by the public utilities commission. If the city does act as a public utility and in the future desires to abandon service outside its limits because of the lack of any surplus water, permission to do so may have to be obtained from the commission. The matter is now before the courts in one or

more cases. Final determination may distinguish between home rule cities and those not in that category.

Even if it is decided that a city acts as a public utility in disposing of water extraterritorially, it may well be that the authority and power of the commission is more circumscribed than for a privately owned utility. Although there appears to be no controlling decision, either by the courts or the commission, it would seem that the commission could have no power to compel a city to furnish extraterritorial service under circumstances in which the city did not have a surplus supply of the commodity. The first duty of a city is to its inhabitants, not to those who live elsewhere. If there is no surplus, the city cannot serve those outside its limits without securing additional sources of supply. The authority of the commission to compel a city to obtain such additional sources is extremely doubtful under the Colorado constitution. In dealing with these questions, consideration might well be given to the desirability of enacting clarifying legislation.

Conservancy District Contracts

One way for a city to avoid the problems arising from the sale or lease of currently surplus water is to become a part of, or contract with, a water conservancy district. A district organized under the 1937 act would probably come within the exemption provisions of the Public Utilities Act. Hence, it may be that such a district could make appropriate contractual arrangements by which a city could obtain a supply for anticipated increased needs without becoming subject to the regulatory powers of the public utilities commission. It might be very profitable for city attorneys to give careful consideration to this possibility. The legality of any plan developed could well be tested by means of the Colorado declaratory-judgment procedure before any substantial financial commitments were made.

Conclusion

This discussion of transmountain diversion has necessarily been somewhat sketchy, and a multitude of minor problems have not even been touched upon. Serious and important as are the legal problems, they become insignificant when compared with the political difficulties. In the past Colorado has suffered too much from selfish bickering for local advantage. The water resources are limited and cooperation is necessary to secure fair and equitable treatment for all. A sympathetic consideration of the needs and potentialities of every section in the state is required. Through a mutual understanding of the problems of all localities and a sincere desire to solve those problems, the full development of Colorado's limited water resources can be attained.

Disposal of Waste Cooling Water

By J. Carl Jennings

A paper presented on Oct. 26, 1949, at the California Section Meeting, Sacramento, Calif., by J. Carl Jennings, Office Engr., Div. of Water & Sewers, Sacramento, Calif.

THE ever growing demand for cooling water has created a problem of supply which has received considerable attention and has been the subject of much discussion. More recently the disposal of waste cooling water has become a problem of first magnitude in many cities. The satisfactory solution of these twin problems is vital to both water and sewage works operators. The situation is of particular interest in California, where the shortage of water is becoming more general and where more and more communities are being forced to build sewage treatment works.

This paper will be confined to the disposal of waste cooling water from air-conditioning and refrigeration equipment, although the use of cooling water is by no means limited to those purposes. Large quantities are used in industrial processes—in fact, the largest single use of water by industry is for cooling purposes other than air conditioning and refrigeration. The disposal of industrial cooling waters presents special problems, usually in newly developed, outlying areas, but these difficulties are frequently solved along with those of supply. The installation of air-conditioning and refrigeration equipment, on the other hand, often takes place in well developed areas where provision has already been made for sewage and storm flows in quantities which were originally considered to be sufficient for ultimate development. The addition of waste cooling waters to the anticipated flow is, in many localities, seriously taxing existing disposal facilities.

Waste Quantities

It is pertinent at this point to consider the quantities of used cooling waters which might be produced by a normal development of air conditioning and refrigeration. Quantities vary from city to city, depending on the temperature of the water supply. The community using a cold well water supply with a temperature of 50°–55°F. has a much different problem from that of the city whose supply comes from relatively warm surface waters. Well waters with temperatures of less than 60°F. may be used for air conditioning merely by passing the air over water-cooled coils. The water consumption of this type of equipment is on the order of 3–8 gpm. per equivalent ton of refrigeration. The community with the warmer surface water must resort to mechanical refrigeration, generally requiring 1.5–2.5 gpm. per ton of refrigeration. This load is not confined to the summer months. Approximately 25 per cent of the installed refrigeration capacity is for commercial refrigeration, a year-round necessity.

A hypothetical example might serve to illustrate the severity of the demands which refrigeration can make on the waste disposal system. Sacramento, Calif., has a combined sewerage system, collecting sanitary sewage, storm flow and other wastes in a single system of sewers. At the flat grades available, and with a velocity of 2.5 fps. in the sewers, an 8-in. sewer, carrying approximately 400 gpm., will handle all the flow from one standard city block very nicely.

It is easy to imagine the day in the future when many of the city's highly developed downtown blocks will have a total installed refrigerating capacity of 200 tons or more. At 2 gpm. per ton of refrigeration, without water conservation equipment, the entire available sewer capacity would be needed to carry the waste cooling water from these units. If the sewers were designed to take sanitary flow only, the situation would be much worse, of course.

Many types of water conservation devices have been developed for use in conjunction with refrigeration, the most common being the atmospheric cooling tower, the induced-draft cooling tower, the spray pond and the evaporative condenser. If properly applied, they will effect a saving of approximately 95 per cent in the usage of water and will virtually eliminate waste to sewers other than from periodic flushing.

The figures on water consumption for air-conditioning purposes reported by various cities are startling. In 1948, 4–9 per cent of Philadelphia's maximum-day water usage was consumed by air-conditioning equipment, with 11 per cent in the congested central area. In Chicago's Loop district, air-conditioning water use has ranged from a low of 22 per cent of a single day's total output to a high of 50 per cent. It may be seen, therefore, that the quantity of water which might be wasted from this source, even with the use of water conservation equipment on the larger installations, represents a sizable disposal problem.

There are, normally, only two widely used methods for disposing of waste cooling water. The most common, of course, is its discharge into the community sewers, either sanitary, storm or combined, depending on their availability. The alternate method of disposal is into drainage or recharge wells.

Sewer Disposal

Where disposal is to be made into community sewers, connection to storm drains should be mandatory in areas fortunate enough to have separate storm and sanitary sewers. By this device, the storm sewers are used for their primary purpose of storm water disposal during the wet season and for the secondary purpose of cooling-water disposal during the warm season, each peak avoiding the other. Moreover, outfall arrangements for the ultimate disposal of storm waters are usually suitable for cooling waters.

The disposal of cooling water into sanitary sewers constitutes a more serious problem. Rarely are sanitary sewers found which have sufficient reserve capacity to handle large added volumes of cooling water. The first difficulty encountered, then, is that of limited capacity. A second, and equally important, deterrent to disposal into sanitary sewers is the necessary increase in the capacity of sewage treatment plants to handle the added flow. This increase seems particularly wasteful, considering the fact that the cooling waters are not in need of treatment

until they are added to, and mixed with, the sanitary sewage. The added quantities which must be treated do not in any way increase the organic load on sewage treatment units, but they do significantly raise capital and operating costs.

As might be expected, the disposal of cooling water into combined sewers presents a combination of the advantages and disadvantages of disposal in either storm or sanitary sewers. Capacities to receive moderate discharges are usually available at the right times, but the added costs of sewage treatment are still present.

Very little local regulation has been designed to control the flow of waste cooling water into sewers. Rather the regulations have been aimed at controlling the rate of use of cooling waters, and thus, indirectly, the waste to sewers. There are countless local ordinances requiring water conservation equipment on installations of more than approximately 5 tons. In fact, the tentative regulations suggested by the A.W.W.A. Committee on Water Use in Air Conditioning recommend a limit of 5 tons, or 10–15-gpm. water consumption, without conservation equipment (1).

Some of the local regulations which specifically control flow to sewers are as follows: Pasadena, Calif., prohibits the discharge of waste water from air conditioning into the sewer system, thus compelling the use of conservation equipment. Wichita, Kan., excludes waste cooling water in excess of 1 gpm. from sanitary sewers. Sacramento prohibits the discharge into sewers of cooling water in excess of 1 gpm. per foot of property frontage. New York limits waste water to an average annual flow of 5 gpm., but this is an ineffective regulation, since peak flows are not controlled. One of the more rigorous regulations, that of the Washington Suburban Sanitary Dist., limits both the supply and waste to 0.08 gpm. per ton of refrigeration, which, in effect, makes mandatory the use of conservation equipment on any size of installation. A number of localities, including Fresno, Calif., prohibit the wasting into sewers of cooling water supplied from ground sources. Many regulations of this type are designed primarily to protect the ground water supply rather than to reduce overloading of sewers.

Drainage Wells

The use of drainage or recharge wells for the disposal of cooling water merits serious consideration, particularly in regions where the ground water table is becoming lower, which is true in large areas of California today. A drainage well is nothing more than a well operating in reverse, into which waste water is pumped and disposed of in underground strata. Such wells depend to a great extent on geology for their effectiveness, being most successful in creviced rock formations. Most engineers agree that such projects are feasible where there is sufficient depth from ground surface to normal water table and where the formations below the surface are sufficiently pervious to water to permit ready percolation. Drainage wells have been rather unsatisfactory in Sacramento, although a few are still in operation. They have a tendency to clog up and refuse to take flow after two to five years of use but can be restored to some extent by pumping. Care must be exercised in employing recharge wells to avoid damage to adjacent supply wells. One of the advantages of well water for use in air conditioning

is its low temperature. When warm cooling waters are returned to disposal wells near pumped supply wells, the temperature of the supply gradually increases, lowering its thermal value. This situation has occurred in several wells in Sacramento, the supply well water temperatures rising as much as 20°F. In Phoenix, Ariz., the temperature of underground water was raised by this practice to such a point that a number of air-conditioning supply wells became useless.

On Long Island, N.Y., there are more than 300 recharge wells, returning a total of 60 mgd. to a dry sand and gravel formation above the water table. Some of these wells discharge as much as 1,000 gpm. to the ground, although most are of 100–550-gpm. capacity. A large number of these have been in service for more than five years without failure.

The California Dept. of Public Health, in a letter to the Sacramento County Health Officer, has expressed itself as dubious about the indiscriminate use of drainage wells "because it is difficult to keep waste water free from contaminating materials. Drainage wells used for cooling waters would not be classed as sewer wells but might make the underground waters unusable or unsuitable for domestic purposes. Therefore, it is important that some control be exercised over the location and construction of such drainage wells."

A few of the local regulations now in effect which are designed to control drainage well operation are as follows: Fresno, Calif., prohibits the drilling of wells within the city unless they are to be used wholly or in part for either the supply or disposal of cooling water. It is further required that all water taken from the ground for cooling purposes be returned to it through drainage wells and that such water be tested every 90 days to meet rigid standards. Miami Beach prohibits the discharge of more than 2 gpm. to sanitary sewers. If a storm sewer is convenient, larger amounts may be discharged to it; otherwise, a drainage well is mandatory. Indiana forbids the use of more than 200 gpm. of ground water for cooling unless the water is recirculated or returned to the ground through recharge wells. Well supplies on Long Island are regulated under the New York State conservation law, which provides that, after use, uncontaminated water must be returned to the ground through a diffusion well. There is not much question that disposal well operation should be under strict local regulation to protect existing ground water supplies.

Sewer Rental Charges

Sewer rental charges have come into widespread use in recent years as a device for financing the construction and operation of sewage collection systems and treatment plants. These rentals are often based on water charges. In Sacramento, for instance, the sewer charge is 25 per cent of the water bill. These charges will vary with the cost of sewage disposal. In Philadelphia, the sewage disposal charge ranges from 100 per cent of the water bill for a ¾-in. water service to 50 per cent for connections of more than 6 in.

These charges, where imposed, serve strongly to discourage the discharge of undue quantities of water. One of the more difficult problems, incidentally, in administering the sewerage charge is determining the amount of cooling water from private wells which is discharged into sewers. The prac-

tice in Sacramento is to have the well pump calibrated and to have an inexpensive electric timing meter installed on the pump motor. Then a simple calculation indicates the output of the well.

Sacramento Problem

Since Sacramento water service is predominantly on a flat-rate basis, the use and disposal of cooling water is of great concern. At present sewage is disposed of by pumping directly into the Sacramento River, without treatment, a practice which the city expects to remedy in the near future by the construction of a treatment plant. The combination of high summer temperatures, low water rates, largely unmetered services and cheap waste water disposal through combined sewers has led to the rather widespread and rapidly growing use of air-conditioning equipment, with little emphasis on water conservation. The city's disposal limit of 1 gpm. of cooling water per front foot of property does not seem to be sufficiently restrictive.

Considerable thought has been given to this problem, including the possibility of metering of all commercial users, further limitations on disposal, and more rigid requirements for recirculation and water conservation apparatus. If such regulations are not adopted, the result will be an increase in disposal costs, particularly when the proposed sewage treatment plant is placed in operation. The answer to the local problem apparently lies in insisting upon the use of water conservation equipment for air conditioning, which will serve the combined purpose of greatly reducing both water demand and waste.

Conclusion

In dealing with cooling-water disposal problems, it is obvious that no prohibition of air conditioning and refrigeration is necessary, in view of the profusion of efficient water conservation devices now available. It will be a rare community, at least in the warmer areas of California, which will not find some regulatory control of cooling-water wastes necessary in the not-far-distant future. The problems of no two communities are alike—each requires individual analysis. It behooves every superintendent of public water and sewage works to study closely the probable future demands upon his system in order to anticipate trouble before it arrives. It is psychologically better, much easier from an administrative point of view and economically sounder to institute any necessary controls before disposal problems become acute. With an intelligent approach, the luxury of air conditioning, now apparently become a necessity, can be accommodated without undue strain on either the water supply or the disposal system.

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Interferences in Alizarin Method of Fluoride Determination

By Michael J. Taras, Herbert D. Cisco and Michael Garnell

A contribution to the Journal by Michael J. Taras, Sr. San. Chemist; Herbert D. Cisco, San. Chemist; and Michael Garnell, San. Chemist; all of Dept. of Water Supply, Detroit.

THE current large-scale experiments in the artificial fluoridation of water are directing attention to the necessity for the accurate routine determination of the fluoride ion.

The bulk of the literature on the colorimetric determination of fluoride bears on visual comparative procedures. Only three sources report the use of photometric methods. One suggests the substitution of purpurin for the accepted alizarin dye (1). In a second method, the bleaching action of fluoride on ferric acetylacetone forms the basis of the determination in the range 0–5 ppm. (2). The narrow spread in the percentage transmittancies between the higher and lower concentrations operates against the adoption of ferric acetylacetone for fluoride control in water plants. In view of the limited number of photometric studies on the alizarin method of determining fluoride (3), additional work on this increasingly important procedure, using modern analytical tools, should be welcome.

During the course of a photometric study of the fluoride determination in the authors' laboratory, it was found that two chemicals commonly employed in water treatment—free chlorine and alum—interfere with the accuracy of the Sanchis-Scott method (4), if distillation is not practiced. Similar findings have been reported by Harris (5) and Todd (3). Since the direct estimation of fluoride ion requires only the simplest laboratory apparatus and few manipulations, the advantages of the method for routine purposes are obvious. Investigation showed that a slight modification in the basic procedure could eliminate the most serious interference, that of free chlorine, without in any way affecting the ease or accuracy of the determination.

Photometric Procedure

Examination of the transmittancy curves (Figure 1) obtained with a Beckman Model DU spectrophotometer * shows the non-ideal nature of the fluoride-alizarin color system. The widest transmission spread between the reagent blank and the fluoride sample occurs in the wavelength region of 525 mμ. Because maximum absorption is registered by the reagent blank at this point, it is necessary to operate toward a transmittancy of 100 per cent, in contrast with the normal photometric procedure of setting the null at 100. Even under these circumstances, the relatively narrow spread between the blank and the sample limits the sensitivity of the reagent and magnifies the deleterious effects exerted by interfering ions.

* A product of National Technical Laboratories, South Pasadena, Calif.

If the nonexistence of chemical interference has been established beyond doubt, the spectrophotometric null can be set closer to 100 per cent—at 80, for example—when examination is made for trace quantities (less than 0.5 ppm.) of fluoride, in order to broaden the spread in transmittancy per unit of concentration. The same applies to other photometric instruments, the setting depending on the green filter and the cell path at hand.

The transmittancy spread is so small that the longest cell path available should be employed. A light path of 100 mm. was used in the Beckman spectrophotometer, yielding a spread of 45 transmission units at a wavelength of 525 mμ over the concentration range of 0.0–1.3 ppm. fluoride when the null point of the reagent blank was set at 55 per cent. A null setting of 80 per cent allowed slightly improved sensitivity in the analysis of fluoride levels below 0.5 ppm. Using the Cenco-Sheard-Sanford Photelometer,* a cell path of 50 mm., in combination with a green filter having a wavelength near 525 mμ, gave a spread of 21 deflection units for the concentration range 0.0–1.4 ppm. fluoride when the null point of the reagent blank was set at 79.

The reagents and manner of addition conformed to the method prescribed by *Standard Methods* (4). The temperature of all samples was brought to 80° ± 1°F. before the alizarin reagent was applied. A temperature of 80°F. represents the maximum to which surface supplies climb during the summer months in the Detroit area. Other temperatures can be used, in keeping with the climate. Upon mixing, the samples were immersed in a water bath adjusted to the same temperature, and after one hour the color was read visually or photometrically against a reagent blank prepared at the same time and receiving exactly the same treatment as the samples.

In the absence of distillation, caution must be exercised in interpreting the results obtained with a natural water. The possibility of interference coupled with experimental error places a 0.2-ppm. limit on the accuracy of the method in the fluoride range below 0.5 ppm. Only when the absence of interference has definitely been demonstrated is the assumption of accuracy within 0.1 ppm. justified. With careful technique, fluoride can be determined accurately within 0.1 ppm. over the middle and higher concentration range.

Spectrophotometric measurements of reaction velocity made in the manner of the typical analysis (that is, by setting the null of the reagent blank at 55 per cent and observing the resultant transmittancy change) revealed that more than 85 per cent of the color development at 1.0 ppm. fluoride takes place within fifteen minutes and optimum development within 45 minutes. For visual and photometric purposes, the best color differentiation occurs within the first hour, the differentiation progressively declining until, after eight hours, a significant reduction in the spread between the transmission units is apparent. Instrumental readings against an untreated distilled-water blank showed that the reduction stemmed from the fact that the fluoridated (1.0 ppm.) sample continues to react with the alizarin reagent at a faster rate than the latter reacts with distilled water. The appreciable narrowing in the spread between the blank

* Made by Central Scientific Co., Chicago.

and the sample indicates the advisability of preparing temporary visual standards at the time of the actual analysis.

The analytical results can be readily reproduced from day to day if a uniform experimental procedure is adopted. It is desirable, however, to plot a new calibration curve for each fresh lot of reagent prepared.

In the hope of improving the current method for photometric purposes, the strength of the reagent was multiplied 2.5, 5 and 10 times, to no avail. Half-strength reagent similarly proved a failure.

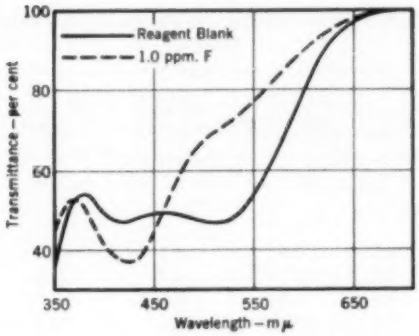

FIG. 1. Spectral Characteristics of Alizarin-Fluoride Color System *

* 10-cm. cell depth (distilled-water reference).

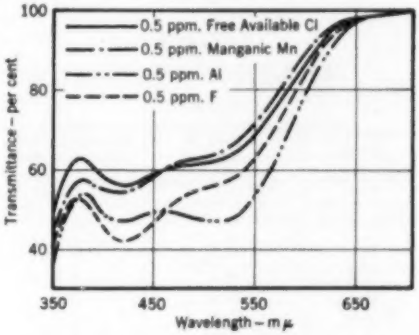

FIG. 2. Spectral Characteristics of Interfering Ions *

* 10-cm. cell depth (distilled-water reference).

Interference Studies

Interference studies were conducted on both distilled water and Detroit filtered water. The residual chlorine in the filtered water was removed by one of three processes: [1] the normal dissipation of chlorine, which results from prolonged sample standing; [2] irradiation with ultraviolet rays from a Hanovia Utility Model Lamp *; and [3] the addition of equivalent amounts of 0.1*N* sodium thiosulfate. The fluoride content of Detroit water, as determined by the distillation method (4), is negligible, approaching 0.0 ppm. The known composition of Detroit water and the similarity of results obtained with distilled and Detroit water corroborated the absence of fluoride or the presence of interfering ions in significant quantities.

The current emphasis on free available residual chlorination in the water treatment field points up the seriousness of the interference that may be caused by the presence of free chlorine in the sample at the time of analysis. Free chlorine has been demonstrated to exert a marked decolorization effect on dyes of the azo group in an acid medium (6, 7). A similar bleaching effect is exerted by free chlorine on the alizarin dye used in the fluoride determination. The bleaching occurs in the presence, as well as in the absence, of fluoride ion. For this reason, it is imperative that free chlorine be removed from a sample being examined for fluoride ion.

The effect of free chlorine alone on the alizarin dye is presented in Table 1.

* Made by Hanovia Chemical & Mfg. Co., Newark, N.J.

The fluoride equivalent of free chlorine doses varies from 0.2 ppm. at 0.1 ppm. free chlorine to 0.9 ppm. at 0.8 ppm. free chlorine, increasing proportionately with higher doses of the disinfectant.

When 0.5 ppm. fluoride is added to variable doses of free chlorine (Table 2), the apparent fluoride is increased additively: 0.1 ppm. at 0.1 ppm. free chlorine and 0.7 ppm. at 0.7 ppm. free chlorine. The slightly smaller effect of the chlorine in this instance probably stems from the difference in the chromatic systems (Fig. 2) produced by free chlorine and fluoride separately and in combination.

TABLE 1

Effect of Free Chlorine Alone

Free Cl Dose	Fluoride Equivalent of Free Cl Alone	Fluoride Equivalent After Dechlorination
	ppm.	
0.1	0.2	0.0
0.2	0.3	0.0
0.3	0.4	0.0
0.5	0.6	0.0
0.6	0.7	0.0
0.7	0.8	0.0
0.8	0.9	0.0

A corresponding effect is evident at 1.0 ppm. fluoride, the concentration suggested for the control of dental caries. A quantitative measure of the chlorine effect at 1.0 ppm. fluoride is difficult, however, because small concentrations of residual chlorine, coupled with fluoride, bleach the dye out of the color range used for the fluoride determination.

The decolorization resulting from free chlorine differs strikingly from that attending fluoride bleaching, an increase in red tone being evident in the chlorine colors. Visual matching is difficult under the circumstances, necessitating comparison on the basis of intensity rather than hue.

A like picture is afforded by colloidal manganese dioxide (Tables 3 and 4), a compound present in some water supplies. As this powerful oxidant bleaches methyl orange in an acid medium (6, 7), a similar reaction with alizarin is not unexpected. The fluoride equivalent of 0.05 ppm. manganic ion alone approaches 0.1 ppm., increasing to 0.8 ppm. at 0.5 ppm. manganic manganese. In the presence of 0.5 ppm. fluoride, the corresponding manganese dioxide dosages increase the fluoride readings additively, part for part. Apparently, the same chromatic factors (Fig. 2) operate as with free chlorine. Manganic doses of 0.5 ppm. applied to 1.0 ppm. fluoride bleach the color out of the measurable fluoride range. The colors yielded by manganese dioxide resemble those of free chlorine more than those of fluoride

TABLE 2

Effect of Free Chlorine in Presence of 0.5 ppm. Fluoride

Free Cl Dose	Total Fluoride Equivalent*	Apparent Fluoride Increase Due to Free Cl	Fluoride Equivalent After Dechlorination
	ppm.		
0.1	0.6	0.1	0.5
0.2	0.7	0.2	0.5
0.3	0.8	0.3	0.5
0.4	0.9	0.4	0.5
0.5	0.9	0.4	0.5
0.6	1.1	0.6	0.5
0.7	1.2	0.7	0.5

* 0.5 ppm. fluoride plus free chlorine.

(Fig. 2). As a result, intensity instead of color must also be the guide when samples are matched visually against standards.

In contrast to free chlorine and manganic ion, aluminum intensifies the alizarin color, yielding an apparent loss in fluoride content. These results confirm the observations made by Harris (5). The aluminum effect (Table 5) is not so pronounced as that of chlorine and manganic ion, the loss ranging from 0.1 ppm. fluoride equivalent at 0.25 ppm. aluminum to 0.4 ppm. at 4 ppm. residual aluminum added as aluminum sulfate. Unlike the other two agents, aluminum does not disclose its identity by modifying the color tone.

TABLE 3

Effect of Manganic Ion Alone

Manganic Ion Dose	Fluoride Equivalent of Manganic Ion Alone	Fluoride Equivalent After Interference Elimination
ppm.		
0.05	0.1	0.0
0.10	0.2	0.0
0.25	0.4	0.0
0.50	0.8	0.0

Although the alizarin dyestuffs have been recommended for the aluminum determination (8), the reagent used in the fluoride determination gives no color change with aluminum ion alone (Fig. 2). Fluoride and aluminum ions must both be present for intensification to take place.

Elimination of Interference

Interference from free chlorine is completely eliminated (Tables 1 and 2) by mixing one drop of 0.1 *N* sodium thiosulfate solution with 100 ml. of sample prior to the addition of the reagent. This volume of thiosulfate is sufficient to dechlorinate immediately 1.8 ppm. of chlorine. Additional drops of thiosulfate may be used to remove greater amounts of free chlorine.

Despite the fact that no marked visual or spectrophotometric effect on the fluoride color system was noted following thiosulfate introduction into the chlorinated sample, it is good practice to add equivalent volumes to the temporary standards or when the calibration curve is prepared.

TABLE 4

Effect of Manganic Ion in Presence of 0.5 ppm. Fluoride

Manganic Ion Dose	Total Fluoride Equivalent*	Apparent Fluoride Increase Due to Manganic Ion	Fluoride Equivalent After Interference Elimination
ppm.			
0.05	0.5*	−0.1	0.5
0.10	0.6	0.1	0.5
0.25	0.8	0.3	0.5
0.50	1.0	0.5	0.5

* 0.5 ppm. fluoride plus manganic ion.

Free-chlorine interference can also be prevented by irradiating the sample, prior to reagent addition, with ultraviolet rays, such as are generated by a Hanovia Utility Model Lamp. In spite of its effectiveness, this procedure requires specialized apparatus and is not readily adapted to routine control.

Manganese dioxide interference is removed (Tables 3 and 4) by reduction with one drop of 3 per cent hydrogen peroxide. After the amber or brown color characteristic of manganic

ion is discharged, usually upon mixing, the residual peroxide is eliminated by the addition of one drop of 3 per cent potassium iodide solution followed by three drops of 0.1 *N* sodium thiosulfate solution. This procedure successfully removes up to 0.5 ppm. manganic ion. As with free chlorine, standards and samples should receive identical treatment. The addition of potassium iodide is optional, inasmuch as sodium thiosulfate alone has proved effective in the removal of the residual peroxide in all samples studied to date in the authors' laboratory.

TABLE 5

Effect of Aluminum Ion in Presence of 1.0 ppm. Fluoride

Aluminum Ion Dose	Total Fluoride Equivalent*	Apparent Fluoride Decrease Due to Aluminum Ion
	ppm.	
0.25	0.9	0.1
0.50	0.9	0.1
1.0	0.8	0.2
4.0	0.6	0.4

* 1.0 ppm. fluoride plus aluminum ion.

Aluminum interference is likely to occur only during periods of poor coagulation and can be eliminated by efficient plant operation.

Summary

A photometric study of the alizarin bleaching method of determining fluoride discloses interference from free chlorine, manganese dioxide and aluminum ion. Chlorine and manganic ion, alone or in the presence of fluoride, affect the readings positively. Conversely, aluminum lowers the fluoride values, but to a lesser extent. Free chlorine can be eliminated by the addition of sodium thiosulfate or by ultraviolet irradiation; manganese dioxide, by reduction with hydrogen peroxide. No impairment in the visual or photometric procedure attends the use of these reagents.

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Total Hardness and Fluoride Content of Oregon Public Water Supplies

By Clara A. Storvick and June H. Sullivan

A contribution to the Journal by Clara A. Storvick, Prof., and June H. Sullivan, Asst. Prof., Dept. of Foods & Nutrition, School of Home Economics, Oregon State College, Corvallis, Ore.

AS part of a study of the factors concerned in the incidence of dental caries among school children in the coastal and central regions of Oregon (1), samples of drinking water were analyzed for total hardness and fluoride content. A list of the public water supplies in use, in 1948, in these regions was obtained from the Oregon State Board of Health. Determinations of total hardness and fluoride were made on samples of 51 of the 75 public water supplies listed. After those analyses had been made, it seemed advisable to extend the investigation by analyzing water samples obtained from the county seats of the remaining 32 counties in the state. Therefore, samples from 83 public water supplies were included in the present study.

Method

Single water samples were collected in chemically clean 2.5-liter bottles and were analyzed shortly thereafter for total hardness and fluoride content.

Total hardness was computed from results of the determinations of calcium, magnesium and iron. After the silica, phosphates, iron, aluminum and manganese had been removed from the water, calcium was determined volumetrically by titration with standard 0.1*N* potassium permanganate solution (2). The results of the calcium analyses were expressed as parts per million Ca^{++}. The analyses for magnesium were made colorimetrically using titan yellow (2). The samples were read in a Beckman spectrophotometer * at a wavelength of 525 mμ, and the results were expressed as parts per million Mg^{++}. The phenanthroline method was used for the iron analyses (2). The samples were read in a Beckman spectrophotometer at a wavelength of 510 mμ, and the results were expressed as parts per million Fe^{++}.

From the data obtained in the analysis of the water samples for calcium, magnesium and iron as described above, the total hardness was calculated (2, 3) as $CaCO_3$, from the equation: ppm. $CaCO_3 = (2.497)$ (ppm. Ca) + (4.115) (ppm. Mg) + (1.7941) (ppm. Fe).

The Scott (4) modification of the Sanchis method was used in the analysis of water for fluorides. Employing a Taylor slide comparator,† the samples were read directly in terms of parts per million F^-.

* Made by National Technical Laboratories, South Pasadena, Calif.

† A product of Taylor & Co., Baltimore, Md.

TABLE 1

Total Hardness and Fluoride Content of Oregon Public Water Supplies

Location of Sample		Time of Analysis*	Total Hardness as $CaCO_3$†	Calcium (Ca^{++})	Magnesium (Mg^{++})	Iron (Fe^{++})	Fluoride (F^-)
County	City or System		ppm.				
1. Baker	Baker‡	B	60	21.4	1.6	0.06	0.0
2. Benton	Corvallis‡	B	32	9.3	2.2	0.02	0.1
	Corvallis (Children's Farm Home)	B	64	15.2	6.4	0.00	0.3
3. Clackamas	Oregon City‡	B	34	13.2	0.4	0.05	0.0
4. Clatsop	Arch Cape	B	24	2.8	4.1	0.00	0.0
	Astoria‡	A	14	2.2	1.9	0.28	0.1
	Brownsmead	B	10	3.3	0.5	0.06	0.1
	Cannon Beach	A	22	4.5	2.7	0.00	0.0
	Clifton	B	19	4.4	2.1	0.00	0.0
	Gearhart	A	9	1.7	1.2	0.03	0.0
	Hammond	A	10	1.4	1.6	0.05	0.0
	Knappa	B	22	5.4	2.0	0.05	0.2
	Rainbow Water System	B	11	2.3	1.4	0.10	0.0
	Seaside	A	9	1.7	1.2	0.03	0.0
	Svensen	A	11	1.6	1.8	0.06	0.0
	Warrenton	A	10	1.4	1.6	0.05	0.0
	Wauna	B	52	14.5	3.7	0.11	0.0
	Wave Crest	B	25	4.7	3.2	0.11	0.0
	Westport Mill	A	10	1.4	1.5	0.00	0.0
	Young's River	B	16	4.5	1.0	0.17	0.0
5. Columbia	St. Helens‡	B	31	9.5	1.6	0.07	0.0
6. Coos	Bandon	A	10	1.1	1.8	0.08	0.0
	Coos Bay	A	40	13.3	1.6	0.00	0.0
	Coquille‡	A	14	2.1	2.2	0.09	0.0
	Eastside	A	40	13.3	1.6	0.00	0.0
	Empire	B	15	3.9	1.3	0.21	0.0
	Myrtle Point	A	48	9.9	5.2	1.24	0.0
	North Bend	A	40	13.3	1.6	0.00	0.0
	Powers	A	26	7.4	1.9	0.03	0.0
	Sandford Heights	A	14	2.1	2.2	0.09	0.0
7. Crook	Prineville‡	B	167	43.5	14.3	0.04	0.0
8. Curry	Gold Beach‡	B	36	7.4	4.3	0.10	0.0
9. Deschutes	Bend‡	A	13	3.0	1.4	0.00	0.2
	Redmond	A	16	2.3	2.4	0.12	0.1
	Shevlin	B	17	3.2	2.3	0.02	0.0
	Sisters	A	18	4.4	1.8	0.00	0.2
	Terrebonne	B	138	26.3	17.5	0.00	0.0
10. Douglas	Roseburg‡	B	26	9.3	0.8	0.04	0.0
11. Gilliam	Condon‡	B	109	29.1	8.8	0.02	0.0
12. Grant	Canyon City‡	B	95	18.8	11.8	0.02	0.0
13. Harney	Burns‡	B	68	18.9	5.0	0.00	0.0
14. Hood River	Hood River‡	B	35	12.4	0.9	0.00	0.0
15. Jackson	Medford‡	B	27	5.9	3.0	0.03	0.0

* A—June 1948; B—May 1949.
† Total hardness as ppm. $CaCO_3$ = (2.497) (ppm. Ca) + (4.115) (ppm. Mg) + (1.7941) (ppm. Fe).
‡ County seat.

TABLE 1—(*contd.*)

Location of Sample		Time of Analysis*	Total Hardness as $CaCO_3$†	Calcium (Ca^{++})	Magnesium (Mg^{++})	Iron (Fe^{++})	Fluoride (F^-)
County	City or System		ppm.				
16. Jefferson	Madras‡	B	109	35.8	4.8	0.00	0.0
17. Josephine	Grants Pass‡	B	48	16.2	1.9	0.00	0.0
18. Klamath	Bly Water Co.	A	58	12.7	6.5	0.00	0.0
	Cascade Summit	B	7	2.3	0.4	0.00	0.0
	Chiloquin	A	12	2.0	1.8	0.00	0.0
	Crater Lake National Park	B	14	4.3	0.7	0.05	0.0
	Crescent Lake	B	25	6.7	2.0	0.00	0.1
	Ellingson's Mill	B	211	35.0	30.0	0 02	0.0
	Fairhaven Heights	A	12	3.5	0.7	0.00	0.0
	Gilchrist Timber Co.	B	17	3.4	2.1	0.00	0.0
	Klamath Agency	B	14	3.0	1.5	0.00	0.2
	Klamath Falls‡	A	41	9.5	4.2	0.02	0.0
	Klamath View Auto Courts	B	83	17.5	9.5	0.00	0.0
	Lake O'Woods	B	12	3.6	0.7	0.02	0.0
	Malin	A	147	24.2	21.0	trace§	0.0
	Merrill	A	38	7.6	4.6	trace§	0.0
	Modoc Point	B	56	12.5	6.0	0.00	0.0
	Smith Lumber Co.	B	67	21.0	3.5	0.00	0.1
	Sprague River	A	83	7.1	15.5	0.08	0.0
	Stewart Lenox	B	136	41.4	8.0	0.00	0.0
	Weyerhaeuser Mill	B	34	10.7	1.7	0.02	0.0
	Weyerhaeuser Camp #4	B	60	11.1	7.8	0.00	0.0
	Weyerhaeuser Camp #6	B	34	8.3	3.1	0.05	0.0
19. Lake	Lakeview‡	B	43	13.8	2.1	0.08	0.0
20. Lane	Eugene‡	B	38	14.3	0.5	0.04	0.0
21. Lincoln	Toledo‡	B	37	13.4	0.8	0.14	0.0
22. Linn	Albany‡	B	36	12.5	1.1	0.06	0.0
23. Malheur	Vale‡	B	520	155.9	31.8	0.00	0.0
24. Marion	Salem‡	B	40	14.7	0.7	0.00	0.0
25. Morrow	Heppner‡	B	66	19.4	4.3	0.00	0.0
26. Multnomah	Portland‡	B	22	7.9	0.5	0.05	0.0
27. Polk	Dallas‡	B	44	15.9	1.1	0.09	0.0
28. Sherman	Moro‡	B	109	28.6	9.3	0.00	0.0
29. Tillamook	Tillamook‡	B	33	11.6	1.0	0.26	0.0
30. Umatilla	Pendleton‡	B	25	6.4	2.0	0.23	0.0
31 Union	La Grande‡	B	26	9.5	0.6	0.09	0.0
32. Wallowa	Enterprise‡	B	161	61.2	2.0	0.00	0.0
33. Wasco	The Dalles‡	B	65	19.2	4.2	0.11	0.5
34. Washington	Hillsboro‡	B	32	10.5	1.3	0.03	0.0
35. Wheeler	Fossil‡	B	49	14.1	3.3	0.06	0.0
36. Yamhill	McMinnville‡	B	18	4.5	1.6	0.04	0.0

* A—June 1948; B—May 1949.
† Total hardness as ppm. $CaCO_3$ = (2.497) (ppm. Ca) + (4.115) (ppm. Mg) + (1.7941) (ppm. Fe).
‡ County seat. § Less than 0.01 ppm.

Results

The total hardness, calcium, magnesium, iron and fluoride content of the 83 samples is shown in Table 1. Figure 1 is a map of Oregon divided by counties, numbered to correspond with Table 1.

In general, the fluoride content of the public water supplies sampled was negligible. According to the *General Engineering Handbook* table on the relative hardness of water (5), all of the samples may be classified as soft, except for those obtained from Prineville, Terrebonne, Ellingson's Mill, Malin, Stewart Lenox, Vale and Enterprise.

Acknowledgment

This study formed part of the "Western Regional Research Project on Nutritional Status of Population Groups in Selected Areas of the State of Oregon, With the Cooperation of the Oregon Agricultural Experiment Station." It was partially financed from funds appropriated under the Research and Marketing Act of 1946. The cooperation and assistance of the U.S. Dept. of Agriculture's Bureau of Human Nutrition and Home Economics and the U.S. Public Health Service is acknowledged.

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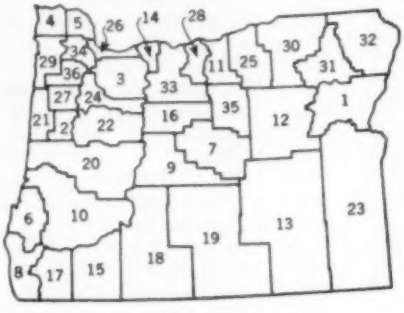

Fig. 1. Oregon Counties

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Design Features of Cleveland's Nottingham Intake

By Harry H. Moseley

A paper presented on Nov. 4, 1949, at the Ohio Section Meeting, Dayton, Ohio, by Harry H. Moseley, Design Engr., Havens & Emerson, Cleveland, Ohio.

THE Nottingham Intake is one of the major projects in a construction program which, when completed, will substantially increase the water supply and distribution facilities of Cleveland, Ohio. The Nottingham Filtration Plant and Pumping Station to which the intake extends is being built on a site approximately 9½ miles east of the Public Square and 1½ miles inland from Wildwood Park on Lake Erie. The adoption of this location was based on consumption needs as evaluated by several engineering boards. The plant is designed for 100 mgd. but is planned to enable a later expansion to 150 mgd.

The intake runs from the filtration plant through Wildwood Park to a submerged crib located approximately 3½ miles offshore. The intake thus involves 1½ miles of land section and 3½ miles of lake section.

The final location of the intake crib was determined from sanitary surveys of lake waters made by the city under the direction of J. W. Ellms, the late commissioner of sewage disposal.

The intake design included the following essential features: [1] a submerged crib located in approximately 50 ft. of water; [2] a 10-ft.-id. intake pipe extending between the crib and a shore shaft; [3] a shore shaft with control gates and surge relief to the lake; and [4] a land section extending from the shore shaft to an existing screen well located on the filtration plant property.

The screen well has an inside diameter of 96 ft. and a depth of 90 ft. below existing grade. Near the bottom, it is provided with an opening for the connection of the future intake. The design capacity of the intake is 150 mgd., but detailed hydraulic studies showed that, for a small additional cost, the shore end of the lake section could be lowered and its capacity economically increased to 200 mgd. Accordingly, the shore end was lowered to make available this additional capacity.

Hydraulic Considerations

The principal hydraulic considerations which influenced the design were lake fluctuations, pipe friction, crib inlet velocity and surge.

Fluctuations in lake level—particularly a depression of the lake surface due to prolonged dry spells or offshore winds—make it necessary for the intake to function under a wide variety of conditions. Consequently, the intake was designed to function at the 200-mgd. rate when the lake level is 3½ ft. below mean low water (U.S.G.S. elevation 570.5). A Hazen-Williams roughness coefficient of 100 was as-

sumed for the lake section and 120 for the land section. This difference in coefficients reflected the allowable alternate use of steel or concrete pipe in the lake section and the possible future condition of the pipe. The crib inlet velocity was set at 0.25 fps. Experience has shown that, in deep water, this velocity through the screens will avoid the risk that anchor or frazil ice might seal off the intake. To prevent surge, the necessary means were furnished to dissipate or release the energy of the column of moving water in 5 miles of pipe.

Type of Construction

The design problem for the land section of the intake was comparatively simple. The decision had already been made, and rightly so, in the construction of the existing screen well, that the raw water would be pumped at the treatment plant site, which, of course, involved gravity flow from the lake and required a land section to be built in a deep tunnel. On the other hand, the construction of the lake section necessitated a study of two methods—tunneling or laying the intake pipe in a trench dredged in the bottom of the lake. Two previous intakes constructed for the city had been built by the tunnel method, which, at the time, was accepted practice for large-size intakes. Gas pockets in the underlying shale, however, had resulted in explosions and several lives had been lost.

Economy and speed of construction would require at least two shafts extending from the tunnel above the surface of the lake. These shafts would have to be almost permanent in nature to withstand the lake storms and ice packs over several seasons. Test borings indicated that, to drive this section of tunnel under free-air conditions, it would be necessary to locate it at a considerable depth below the lake bottom. The borings gave no assurance, however, that water would not be encountered, requiring the use of compressed air and probably presenting special hazards on account of gas. On the other hand, the tunnel could be constructed throughout the year from the land end and at a more uniform rate from the lake shafts during the open season on the lake, in contrast to open-cut dredging, which would be more subject to lake conditions.

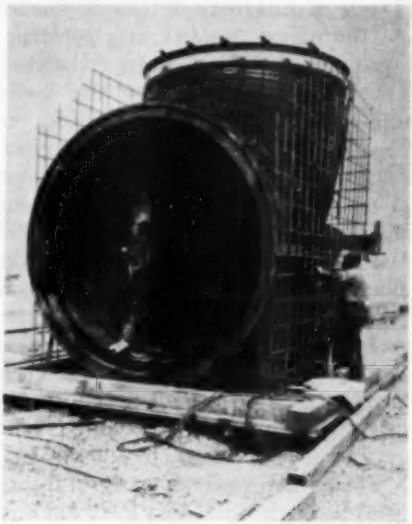

FIG. 1. Construction of Intake Elbow

The possibility of constructing the intake in an open trench resulted largely from the rapid development and increase in size of dredging equipment. Within the last decade, large-size pipe intakes had been successfully constructed in the Great Lakes by this method. Conferences with marine contractors established the fact that suitable equipment for dredging to a depth of 65 ft. was available and could be brought to Cleveland.

Further study also indicated the feasibility of laying and jointing a 10-ft.-diameter intake of steel or concrete pipe underwater. The hazards encountered in this type of construction would again be substantially less than in tunneling. It was recognized, however, that the intake would have to be built during the summer months.

Considerations of this nature, supplemented by examination of boring cores and by studies of comparative costs, finally led to the decision to build the lake section in an open cut. To facilitate operations, a breakwater harbor was constructed at the land end of the intake, large enough to protect the marine equipment of the contractor during stormy weather.

Crib Design

The crib is of the submerged type, which eliminates the cost of maintenance and labor that would be needed for one extending above the water. In conformance with the requirements of the U.S. War Dept., the top of the crib is 40 ft. below the mean low lake level of 570.5. This kind of structure is often built as a grid of heavy timbers framed to form pockets around risers extending up from the intake pipe. As timbers of the size and number needed for a crib of the capacity required were not readily available at the time, a steel structure was decided upon.

As designed, the crib is something like a drum with parts of the two heads omitted. It is 76 ft. in diameter and 12 ft. deep and is fabricated of ¾-in. plate, well reinforced with angles and other structural shapes. Steel surfaces exposed to flowing water are coated with reinforced, gunited mortar ¾ in. thick, while other surfaces have a bituminous coating. The bottom head of this drum is completely floored with plate except for a center hole 18 ft. in diameter into which is welded a vertical collar extending 6 ft. up into the drum. This opening surrounds the upturned elbow of the intake pipe.

The interior of the drum or crib is broken up into a series of three concentric compartments by a system of radial arms and octagonal frames. The innermost compartment is essentially a structural element, being a compression ring 6 ft. in diameter and 4 ft. deep, formed of 1-in. plate and attached to the upper deck or head of the drum. From this compression ring radiate the eight structural diaphragm members which extend like the spokes of a wheel between the top and bottom to the periphery of the crib. The second row of concentric compartments takes up the greater part of the structure, being about 28 ft. wide and covering the full circumference of the crib, unbroken except by an interior baffle extending downward from the top plate. This part of the structure is decked over with steel plate for about half its width, the rest of the area consisting of wood screens made up of 3 × 12-in. lumber framed to provide 3-in. clear openings. The third and outermost ring of the crib is 7 ft. wide and is divided into sixteen equal compartments.

Every alternate compartment of the outer ring was made watertight with top, bottom and side plates. The remaining eight compartments were open at the top. The watertight compartments were intended to float the crib, which weighed 360 tons unloaded and which was designed the same as a ship, to permit fabrication at some distance from its final location and towing into place. The compartments were so designed that the crib could

be hydraulically balanced and lowered into position with any desired load on the placing equipment.

The foundation for the crib consists of a leveled cushion of 1½–4-in. stone, 3 ft. thick, in the bottom of an excavation 90 ft. in diameter and 5 ft. deep.

After the placing of the crib, the remainder of the surrounding excavation was filled with stone and the sixteen outer compartments with concrete. Thus loaded, the net effective weight of the structure was about 1,100 tons. To deflect anchors and other dragging objects, three layers of 5-ton blocks of stone were placed around the crib, the bottom layer extending out approximately 16 ft.

The crib is 76 ft. in diameter and is surrounded by large stone stands, with its top 10 ft. above lake bottom. Water enters through screens in the top deck, under one baffle and over another, into the upturned elbow (Fig. 1) of the intake pipe. The baffles, incidentally, are designed to entrap sand. The clear or open area of the intake screen is more than ten times that of the intake itself, and intervening waterways under and over the baffles are proportioned so that there will be a progressive increase in the velocity of the water from a minimum of 0.25 fps. through the screens to 3 fps. in the pipe when operating at design capacity. It will be recalled that the screens themselves are of wood, this material being chosen because of low heat conductivity, as a further safeguard against the attachment of anchor ice.

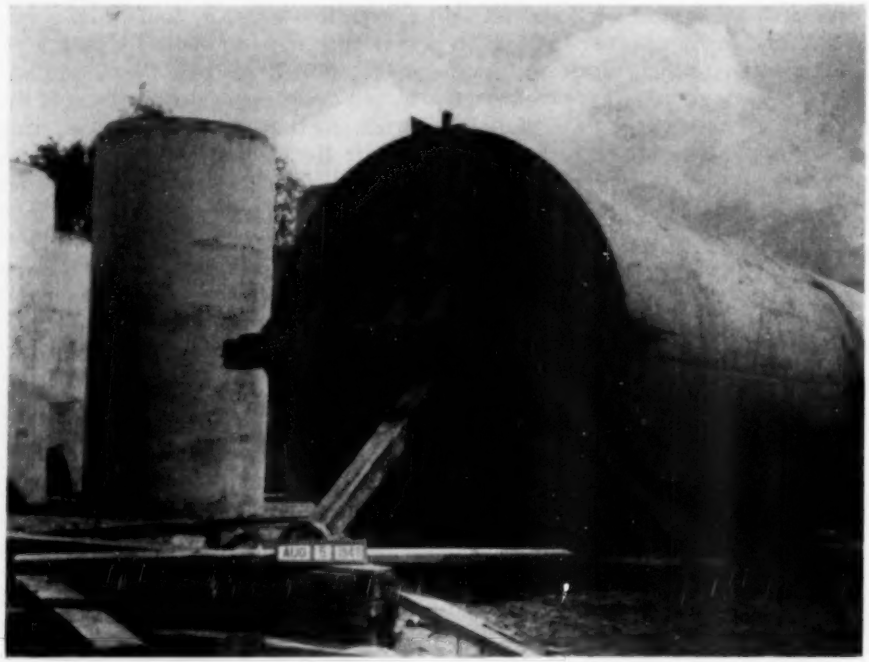

FIG. 2. Bulkhead for Testing Concrete Pipe

Lake Section

The lake portion of the intake itself consists of 18,500 ft. of 10-ft.-id. pipe extending from the crib to the shore shaft. In conformance with the requirements of the U.S. War Dept., a minimum cover of 4 ft. was specified. The pipe is designed to be laid in an open trench dredged to the desired depth. To prevent air pockets in the line, the pipe is laid on a rising grade from crib to shore shaft.

Soundings were taken to establish the general profile, but the contract required that the contractor take soundings at 100-ft. intervals as the work progressed, to establish the final grade. Any minor changes in grade on the intake were to be dealt with by the flexibility in the pipe joints.

After the pipe had been brought into position and successfully tested, the trench was backfilled to the original lake bottom. Excess excavation was disposed of at the government dumping ground in Lake Erie.

It was apparent that, inshore, conformity to the hydraulic grade line and rapid slope of the lake bottom necessitated a deep trench. Here a steel sheet pile cofferdam was designed, which was also used to support a surge overflow channel from the shore shaft.

The intake specifications permitted the use of either reinforced concrete pipe or steel pipe. The latter was to have a maximum length of 40 ft. and a 1-in. thickness of shell plates and was to be reinforced with ¾-in. plate rings, the number depending upon the depth of the cover. Reinforcing rings were required at each end in order to maintain a circular section and facilitate jointing. Joints for steel pipe were to be a modified Dresser type, and each was provided with two harness bolts engaging lugs on each pipe. No bid was received on using steel pipe.

FIG. 3. Pipeyard at Wildwood Park

The concrete pipe specified was to have generally a laying length of 24 ft., although in the cofferdam at the shore end, and when necessary for closure pieces, shorter lengths could be used. The contractor was permitted to modify the design of the pipe and cast it in lengths up to 100 ft. if he so desired. The specifications for such modifications, however, were rigid as to type of forms, unit stresses and launching procedures.

The pipe has been cast in 24-ft. lengths and conforms to A.S.T.M. specifications for culvert pipe made from 4,500-lb. concrete. The wall thickness is 10 in. and there are three lines of wire reinforcement. Joints are of the tapered slip type, in which the contact surfaces are steel rings embedded and anchored to the walls of the pipe section, tightness being achieved by a neoprene gasket placed between the contact faces of the joint. Adjacent lengths of pipe are tied together by a pair of 2-in. harness bolts, located diametrically opposite at the springing line and engaging matching lugs well anchored to the pipe reinforcing. These harness bolts and lugs are placed on the pipe to help draw the joints together, to prevent the excessive movement of the pipe before backfilling and to forestall the later opening of joints if, for some unforeseen reason, the pipe should shift or be disturbed. Permission was given to lay two sections of pipe at one time if the contractor used a properly designed strongback and slings. The threaded ends of all bolts to be used under water are turned down to the root of the thread for a distance equal to the diameter of the bolt, in order to facilitate the starting of the nuts.

Because of the low pressures encountered, there was considerable discussion, during the design period, on whether or not the lake section should be tested after installation. It was felt, however, that the amount of the initial investment and the desirability of having the line tight to prevent infiltration along its length required some type of test. Since it was desirable, also, to test the intake in comparatively short lengths, it was required that each 500-ft. section of the intake be tested as laid, under an internal hydrostatic pressure 10 psi. greater than the pressure of the surrounding lake water at the time of test, with the permissible leakage during a 30-minute continuous test period fixed at 0.25 gal. per lineal foot of pipe (*see* Fig. 2).

Shore Shaft

The lake section of the intake terminates in the shore shaft, a circular structure located about 25 ft. from the water's edge. The shaft is to be a permanent structure with an internal working diameter of 19 ft. and extending downward 88 ft. from the original grade. The reinforced concrete walls are 18 in. thick and the floor at the shaft bottom is 30 in. thick. The lake section of the intake enters the shaft approximately 30 ft. below grade, and the land tunnel section leaves the shaft approximately 85 ft. below grade. Liner plates are used for that portion of the structure above rock or sound shale and are extended a distance of 5 ft. into the rock or shale.

The shaft above grade is surmounted by a small, circular building in which will be housed stop planks, sluice gates and operating stands, and a protected vent to the outside. Either of the two 72 × 84-in. sluice gates, which permit the dewatering of the land section, may be removed or repaired without interrupting the flow of water through the shaft. Immediately below the ground floor of this building and above the highest recorded lake level are weirs around the periphery of the shaft. These weirs are designed to bypass the full flow of the intake and discharge it to a channel which leads back to the lake. This surge condition could arise if all the raw-water pumps at the pumping station were shut down suddenly,

and relief at this point will reduce the surge effects at the treatment plant.

Harbor Area

The harbor at the shore end of the intake is intended as a refuge for the floating equipment and as a protection for the shore shaft and overflow channel. Wildwood Park is relatively remote from safe harbors having sufficient depth to house the floating equipment required for this type of construction. Facilities are also offered for loading the pipe from the pipeyard, which is located within the park (Fig. 3). The harbor, formed by breakwaters on three sides, is about 700 by 600 ft. in area. The breakwaters are of the standard rubble mound construction, with quarry stone core faced with slope and deck blocks of 5 tons. There are 10-ton toe blocks at the bottom of the slopes.

Land Section

The land or tunnel section of the intake (Fig. 4), 10 ft. in diameter and approximately 8,500 ft. long, connects the shore shaft with the existing screen well. It is designed as a free-air tunnel with a nominal bore of 12 ft. and a constant grade of 0.5 per cent rising from the shore shaft. The preliminary design work called for a tunnel of lesser depth at the shore shaft, rising on a uniform grade to the screen well. As the logs of the borings became available, however, it was soon apparent that, if the free-air method of tunneling was to be used, the shore shaft would have to be made deeper in order to obtain a solid roof of at least 10 ft. of good, hard shale. The hard blue shale through which the tunnel is constructed has a tendency to break off in large blocks and disintegrate if exposed to air containing much moisture.

It was not contemplated that any large amount of reinforcement would be needed in the tunnel lining, but, as a precaution, designs were made for sections using liner plates, for rib reinforcing with lagging and for a reinforced concrete section. Provision was made also for grouting and for tunnel drains required during construction.

FIG. 4. Completed Intake Tunnel

In order that the tunnel should be as smooth as possible, the specifications required the use of collapsible steel forms built in comparatively short sections. To facilitate the placing and inspection of concrete, 18 × 24-in. doorways were provided along the crown and sides at 5- and 10-ft. intervals, respectively. The concrete was to be vibrated to obtain maximum density.

As in all tunnel work where overbreakage may be expected, work quantity and contract performance stipulations included the usual scaling down, dry packing and pressure grouting behind the lining when found necessary by the city.

The method of tunneling was left up to the contractor, subject to the approval of the city. The specifications imposed a number of requirements in view of the possibility of striking gas. The safety engineer on the job was equipped to detect the presence of dangerous gases, for which maximum concentrations were fixed. It was also required that four 2½-in. pilot holes be drilled at least 15 ft. beyond the tunnel heading at all times to detect gases and help bleed them off when encountered. All power wiring was explosion proof, and only storage battery floodlights or battery cap lights were allowed within 150 ft. of the heading.

Ventilation was furnished by an exhaust system with a capacity of 10,000 cfm. for each heading. The ventilating system assured the men working in each heading of ample air and had sufficient capacity to clear the heading of gases after blasting in a comparatively short time.

The design necessitated two shafts but did not preclude the contractor from doing his construction from one or more additional shafts. No payment was specified for any additional shaft, however, and it was required that the location be restored to its original condition.

Contractors and Consultants

The division of the work between lake and land made possible two separate proposals and contracts. The contractor for the lake section is the Merritt-Chapman and Scott Corp., whose contract involves the submerged crib, 18,500 ft. of concrete intake pipe, 70,000 tons of breakwater and crib protection stone, 240 tons of steel sheet piling and 440 cu.yd. of concrete. The work was bid on a unit price basis, with an estimated construction cost of $4,261,942. The lake section is not yet completed.

The contractor for the land section, including shore shaft, is the Kalill Co., of Cleveland. The performance of this contract calls for approximately 45,000 cu.yd. of excavation, 20,600 cu.yd. of concrete and 52,000 lb. of liner plates. The total estimated cost was $1,844,740.

The aggregate estimated cost for the whole project is $6,106,582, equivalent to about $226 per lineal foot of total intake, including crib, shore shaft and breakwater.

This project is being carried out by the Cleveland Dept. of Public Utilities, Emil J. Crown, Director. Other officials associated in the work are Frank J. Schwemler, Comr., Div. of Utilities Eng., and George W. Hamlin, Comr., Div. of Water and Heat. Havens and Emerson of Cleveland and New York are the consulting engineers, with A. A. Burger, Partner, in charge of design and construction. Ole Singstad advised on matters of tunneling.

SW1.60-T
1950

American Water Works Association

Tentative
STANDARD SPECIFICATIONS
for
TRISODIUM PHOSPHATE

These "Tentative Standard Specifications for Trisodium Phosphate" are based upon the best known experience and are intended for use under normal conditions. They are not designed for use under all conditions and the advisability of use of the material herein specified in any water treatment plant must be subjected to review by the chemist/engineer responsible for operations in the locality concerned.

Approved as Tentative by the Board of Directors of the A.W.W.A. on April 3, 1950

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These "Tentative Standard Specifications for Trisodium Phosphate" were prepared under the direction of C. K. Calvert (deceased) and J. E. Kerslake of the Water Purification Division, A.W.W.A. The specifications were approved by the officers of the Water Purification Division and were submitted for review to producers and consumers of the materials involved, whose comments were then considered by R. C. Bardwell, acting as referee. The text as finally edited was approved by the Committee on Water Works Practice and received the approval of the Association's Board of Directors on April 3, 1950.

Tentative

Standard Specifications for Trisodium Phosphate

Part A—Material Specifications

Sec. 1A—Scope

These specifications cover trisodium phosphate for use in the treatment of municipal and industrial water supplies. The specifications are intended for use in connection with Part B (Sampling, Inspection, Packing and Marking) and Part C (Testing Methods) of this document.

Sec. 2A—Definition

Trisodium phosphate is a manufactured product, either granular, flake or crystalline, the active ingredient of which is the equivalent phosphoric anhydride content.

Sec. 3A—Sampling

Sampling shall be conducted in accordance with Part B (Sampling, Inspection, Packing and Marking) of this document.

Sec. 4A—Methods of Testing

The laboratory examination shall be carried on in accordance with Part C (Testing Methods) of this document.

Sec. 5A—Impurities

The trisodium phosphate supplied under these specifications shall contain no soluble mineral or organic substances in quantities capable of producing deleterious or injurious effects upon the health of those consuming the water which has been treated properly with trisodium phosphate.

Sec. 6A—Rejection

6A.1. Notice of dissatisfaction with a shipment, based on the specifications, must be in the hands of the consignor within ten days after receipt of the shipment at the point of destination. If the consignor desires a retest, he shall notify the consignee within five days of notice of the complaint. Upon receipt of the request for a retest, the consignee shall forward to the consignor one of the sealed samples. In the event that the results obtained by the consignor, on retesting, do not agree with the results obtained by the consignee, the other sealed sample shall be forwarded, unopened, for analysis to a laboratory agreed upon by both parties. The results of the referee analysis shall be accepted as final and the cost of the referee analysis shall be paid for by the party whose results show the greatest discrepancy from the referee results.

6A.2. On the basis of the retest or the referee test, the consignor may remove the material from the premises of the consignee or a price adjustment may be agreed upon by the consignor and consignee.

Sec. 7A—Insoluble Matter

The insoluble matter shall not exceed 0.1 per cent.

Sec. 8A—Alkalinity

The alkalinity to methyl orange, calculated as Na_2O, shall be not less than 16 nor more than 19 per cent.

Sec. 9A—Trisodium Phosphate Content

The trisodium phosphate, calculated as $Na_3PO_4 \cdot 12H_2O$, shall be not less than 98 per cent, which is equivalent to 18.3 per cent expressed as phosphoric anhydride (P_2O_5).

Part B—Sampling, Inspection, Packing and Marking

Sec. 1B—Scope

These procedures for the sampling, inspection, packing, weighing and marking of trisodium phosphate are intended for use in connection with Part A (Material Specifications) and Part C (Testing Methods) of this document.

Sec. 2B—Sampling

2B.1. Samples shall be taken at the point of destination.

2B.2. If the trisodium phosphate is handled by conveyor or elevator, a mechanical sampling arrangement may be used.

2B.3. If the material is packaged, 5 per cent of the packages shall be sampled. No sample shall be taken from a broken package.

2B.4. Trisodium phosphate may be sampled, by the use of a sampling tube which is at least $\frac{3}{4}$ in. in diameter, from carload shipments in bulk or from packages.

2B.5. The gross sample, weighing at least 10 lb., shall be mixed thoroughly and quartered to provide three 1-lb. samples. These shall be sealed in airtight, moistureproof glass containers and kept in a cool place. Each sample container shall be labeled to identify it and the label shall be signed by the sampler.

Sec. 3B—Packing and Shipping

3B.1. Trisodium phosphate may be specified to be shipped in bags containing 100 or 200 lb., in kegs of 125 lb., in drums containing 375 lb., in fiber drums containing 325 lb. or in bulk.

3B.2. The net weight of packages shall not deviate from the recorded weight, plus or minus, by more than 2.5 per cent. If exception is taken to the weight of the material received, it shall be based on a certified unit weight of not less than 10 per cent of the packages shipped, selected at random from the entire shipment.

Sec. 4B—Marking

Each shipment of material shall carry with it some means of identification. Each package shall have marked legibly thereon the net weight of the contents, the name of the manufacturer and a brand name, if any. The package may bear also the statement "Guaranteed by (name of manufacturer) to meet the specifications of the American Water Works Association for trisodium phosphate."

Part C—Testing Methods

Sec. 1C—Scope

These methods for the examination of trisodium phosphate are intended for use in connection with Part A (Material Specifications) and Part B (Sampling, Inspection, Packing and Marking) of this document.

Sec. 2C—Sampling

2C.1. Sampling shall be conducted in accordance with Part B (Sampling, Inspection, Packing and Marking) of this document.

2C.2. The sample delivered to the laboratory shall be quartered to ap-

proximately 100 g. and this amount reduced by mechanical grinding, or in a mortar by hand, to such size that all of it passes a 30-mesh sieve. After thorough mixing, this sample should be stored in an airtight glass container and weighed out of it rapidly to avoid change in moisture content. The sample should be held at a low temperature, because there is a tendency for the water of crystallization to be given off.

2C.3. The laboratory examination of the sample shall be completed within five working days after receipt of the shipment.

Sec. 3C—Insoluble Matter

3C.1—*Procedure:*

3C.1.1. Weigh accurately about 10 g. of the sample and add to 150 ml. of hot water. Stir until dissolved.

3C.1.2. Filter through a Gooch crucible and wash until free from phosphate.

3C.1.3. Dry to constant weight at 100–105°C.

3C.2—*Calculation:*

$$\frac{\text{Weight of insoluble matter}}{\text{Weight of sample}} \times 100 = \text{per cent insoluble matter}$$

Sec. 4C—Total Alkalinity

4C.1—*Reagents:*

(a) 0.5 *N* sulfuric acid
(b) Methyl orange indicator

4C.2—*Procedure:*

4C.2.1. Weigh accurately about 2 g. of the sample and dissolve in 400 ml. of distilled water in a 600-ml. beaker.

4C.2.2. Add three drops of methyl orange indicator and titrate with 0.5 *N* H_2SO_4.

4C.3—*Calculation:*

$$\frac{\text{ml. of 0.5 } N\ H_2SO_4 \times 0.0155}{\text{Weight of sample}} \times 100 = \text{total alkalinity } (Na_2O)$$

Sec. 5C—Phosphoric Anhydride

5C.1. *Reagents.* All reagents must be made with carbon dioxide–free water, which may be prepared by thoroughly boiling and cooling distilled water:

(a) 0.5*N* H_2SO_4 (standardize against NaOH which has been standardized against U.S. Bureau of Standards acid postassium phthalate using phenolphthalein as indicator)

(b) approximately 6.0 *N* ammonium hydroxide (NH_4OH)

(c) Molybdate solution (mix 100 g. of pure molybdic anhydride or 118 g. of 85 per cent molybdic acid with 400 ml. of distilled water and add 80 ml. of NH_4OH [5C.1(b)]; when solution is complete, filter and pour the solution slowly and with constant stirring into a mixture of 400 ml. of concentrated nitric acid [5C.1(i)] and 600 ml. of distilled water; settle for 24 hours and use the clear supernatant liquid)

(d) 1 per cent potassium nitrate (KNO_3) solution

(e) 0.3*N* NaOH, standardized against U.S. Bureau of Standards acid potassium phthalate using phenolphthalein as indicator

(f) 0.3 *N* nitric acid (HNO_3), standardized against NaOH [5C.1(e)] using phenolphthalein as indicator

(g) Phenolphthalein indicator

(h) Methyl orange indicator

(i) Concentrated HNO_3 (sp.gr. 1.42)

(j) Carbon dioxide–free water made by thoroughly boiling and cooling distilled water

5C.2. *Procedure.* Using the recently boiled and cooled distilled water for all solutions:

5C.2.1. Accurately weigh about 5 g. of the sample and dissolve in distilled water in a 1,000-ml. flask. Make up to 1 liter and mix thoroughly.

5C.2.2. Measure 50 ml. of the solution (5C.2.1) and place in a 300-ml. Erlenmeyer flask.

5C.2.3. Add, with mixing between additions, 25 ml. of HNO_3 [5C.1(i)], 25 ml. of distilled water, 40 ml. of NH_4OH [5C.1(b)] and 50 ml. of molybdate solution [5C.1(c)]. Stopper, shake ten minutes and allow to stand at room temperature until the precipitate settles.

5C.2.4. Filter through an 11-cm. close-grain filter, wash the flask and precipitate five times with KNO_3 [5C.1(d)]. Then wash the precipitate five times, being careful to wash the paper down from the top each time and allowing the filter to drain completely before adding more wash water. Each portion of wash water should be not less than 15 nor more than 20 ml.

5C.2.5. Transfer the paper and precipitate to the flask in which the precipitation was made, add enough 0.3*N* NaOH to decompose the precipitate and then add 2 ml. in excess.

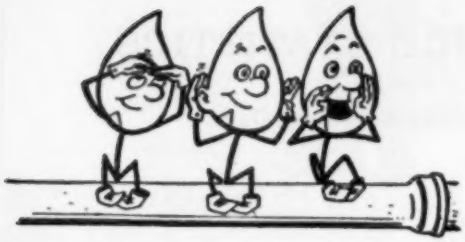
5C.2.6. Add 25 ml. of distilled water and shake vigorously. Rinse the stopper into the flask and dilute the volume to approximately 150 ml.

5C.2.7. Add six drops of phenolphthalein indicator and titrate with 0.3 *N* HNO_3. Then add 0.3 *N* NaOH until the recurrence of color, and titrate to the endpoint again with 0.3 *N* HNO_3.

5C.3—*Calculation:*

$$\frac{(\text{Total ml. } 0.3\ N\ \text{NaOH} - \text{total ml. } 0.3\ N\ HNO_3) \times 1.86}{\text{Weight of sample}} = \text{per cent phosphoric anhydride } (P_2O_5)$$

$$\text{Per cent } P_2O_5 \times 5.352 = \text{per cent trisodium phosphate } (Na_3PO_4 \cdot 12\ H_2O)$$



Percolation and Runoff

The convention story would be exceedingly dead fish if we were to wait to tell it honestly and after the fact. Thus, we'll give you the word now that it must have been a record breaker in every phase of its activities and set up our Conference Statistics page (see p. 2) with the promise that our printer will shoehorn in the final facts as the presses are practically rolling. If the "amazing" speed which will enable us to get these facts in your hands only a fifthnight after the Conference is over does not properly impress you daily newspaper readers, be thankful at least that you don't yet have to ask, "Which Conference?"

Which Conference was also brought home to at least a million and a half radio listeners, when, on May 24, Johns-Manville's "Bill Henry and the News" broadcast, over a nationwide hook-up of 404 Mutual Broadcasting System stations, carried the following message:

Tonight Johns-Manville extends greetings to the American Water Works Association, whose members are holding their seventieth annual convention in Philadelphia this week. Water works men from all over the country have assembled there to discuss ways of improving their service to you. In typical American fashion, they talk over their mutual problems and exchange ideas for the common good. This is an important reason why our water works systems have become the finest in the world. As manufacturers of Transite Pipe, it is Johns-Manville's privilege to serve many of these men of the water works industry. We salute the American Water Works Association for the work it is doing in helping to assure the fine water service which all of us take so much for granted today.

Short schools to be held in Pennsylvania during June include the Third Annual Sewage Works School, June 19 to 23, and the Third Annual Water Works School, June 26 to 30. Further information may be obtained from Robert E. Stiemke or R. R. Kountz of the Dept. of Civil Engineering, Pennsylvania State College, State College, Pa. Both courses will be held at State College.

(*Continued on page 4*)

CONFERENCE STATISTICS

(Story on p. 1)

Philadelphia Registration by Days

Day	Men	Ladies	Total
Sunday, May 21	485	131	616
Monday, May 22	799	180	979
Tuesday, May 23	182	13	195
Wednesday, May 24	120	5	125
Thursday, May 25	92	—	92
TOTALS	**1,678**	**329**	**2,007**

Geographical Distribution of Registrants

UNITED STATES & TERRITORIES

Alabama	26	Maryland	58	South Dakota	2
Alaska	1	Massachusetts	51	Tennessee	22
Arizona	4	Michigan	35	Texas	34
Arkansas	3	Minnesota	29	Utah	2
California	65	Mississippi	2	Vermont	3
Colorado	12	Missouri	43	Virginia	40
Connecticut	22	Montana	—	Washington	6
Delaware	17	Nebraska	7	West Virginia	9
Dist. Columbia	20	Nevada	—	Wisconsin	33
Florida	37	New Hampshire	3	Wyoming	—
Georgia	40	New Jersey	207		
Hawaii	5	New Mexico	—		
Idaho	—	New York	304		
Illinois	118	North Carolina	31		
Indiana	30	North Dakota	3		
Iowa	31	Ohio	87		
Kansas	18	Oklahoma	9		
Kentucky	25	Oregon	6		
Louisiana	15	Pennsylvania	396		
Maine	—	Puerto Rico	4		
		Rhode Island	20		
		South Carolina	16		

CANADA, CUBA & FOREIGN

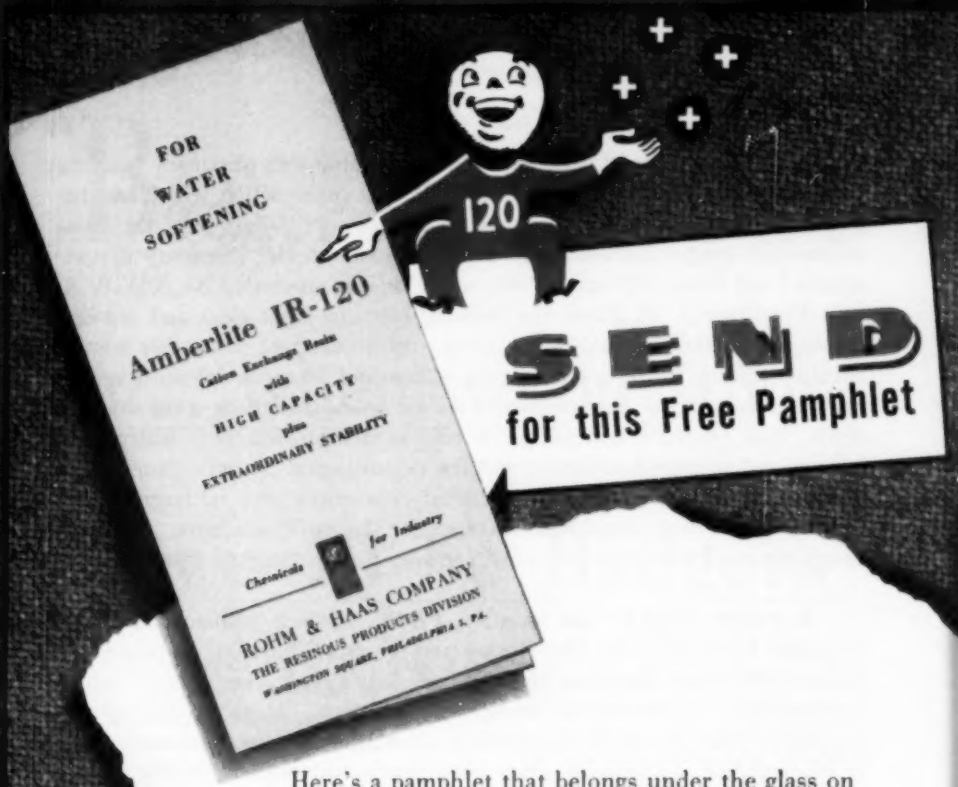
Bermuda	1
Canada	41
Cuba	8
Dominican Republic	1
Egypt	1
Israel	1
Japan	2
TOTAL	**2,007**

Comparative Registration Totals—1941–1950

Year	Place	Men	Ladies	Total
1950	Philadelphia	1,678	329	2,007
1949	Chicago	1,593	374	1,967
1948	Atlantic City	1,348	356	1,704
1947	San Francisco	1,115	431	1,546
1946	St. Louis	1,303	214	1,517
1944	Milwaukee	1,185	171	1,356
1943	Cleveland	973	158	1,131
1942	Chicago	1,198	240	1,438
1941	Toronto	1,136	309	1,445

Win, Place & Show in Section Awards

Henshaw Cup		Hill Cup		Old Oaken Bucket	
Arizona	**72.5%**	**Arizona**	**393.9**	**California**	**833**
Montana	64.0%	Chesapeake	66.6	New York	663
Cuban	61.4%	Ky.-Tenn.	47.4	Southwest	620



Here's a pamphlet that belongs under the glass on the desk-top of anyone interested in economical, trouble-free water softening. Into 5 tables and 811 words we've squeezed a description of AMBERLITE IR-120, the synthetic resin exchanger that resists chlorine, attrition, and waters low in silica — that retains its high capacity despite salt-starvation and years of service in municipal softening.

Plan to install a new, high-capacity softening unit? To replace zeolites of low capacity with a resin of high capacity and efficiency? Then you owe it to your water supply to write to Department WWI-3 for your copy of the pamphlet on AMBERLITE IR-120.

AMBERLITE is a trade-mark, Reg. U.S. Pat. Off. and in principal foreign countries.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company

(Continued from page 1)

The University of Florida's new chemistry and pharmacy building was dedicated on April 15, upon completion of construction which had begun in 1927 and progressed, portion by portion, until addition of the latest section last year. Named Leigh Hall, in honor of the chemistry department's head from 1920 until 1949, when he was succeeded by A.W.W.A. Past-President A. P. Black, the building contains eight class and seminar rooms, an auditorium, and, in the chemistry department alone, five administrative offices, thirteen combination office and research laboratories for staff members, 26 research laboratories for twice that many graduate students, four graduate and advanced course laboratories, plus instrument, balance and preparation rooms, and the departmental library. Among the facilities available for students of sanitary chemistry are one large central laboratory and two research laboratories for the use of students. Two undergaduate and five graduate courses in water chemistry are offered.

A major tragedy has befallen P&R. Having withstood with remarkable fortitude every Dry Friday and Thirsty Thursday occasioned by the well-publicized depletion of New York City's reservoirs, we now find it mortifying to succumb to the depletion of our own. More mortifying still, we cannot place the blame upon either natural deficiencies or abnormalities of consumption. Even our future planning was exemplary. Only trouble was we went to sleep—and when we woke up and found ourself already at our station, our semiconscious propulsion device had us out on the platform waving farewell to a full supply of as yet untreated P&R. Two weeks of frantic consultation with every station agent on New York Central's Harlem Division commuting line have failed to recover the old supply. Meanwhile, we've reduced pressure, hoarded every drop of information and looked high and low for some emergency source—to what avail is all too obvious.

But then—perhaps our sleep was good for you.

(Continued on page 6)

PALMER *Filter Bed* AGITATORS

Prevent Sand Beds From Cracking
Eliminate Mud Balls
Save Wash Water
Lengthen Filter Runs
Higher Rates of Filtration

STUART CORPORATION, 516 N. Charles Street, Baltimore 1, Md.

"Badger Meters are the *best*...when we buy more they will be Badgers"

A waterworks superintendent wrote this, and went on to say: "Our average dead meters for a year was only 7 per month . . . about as low an average as I know of. Your city cannot go wrong buying Badgers".

Millions of satisfied users of Badger Meters in over 5000 communities prove that "It Pays to BUY BADGER" . . . unmatched in precision-construction, durable materials, and sustained accuracy, at lowest operating cost.

ANOTHER NEW Badger Chart, No. 696 (Practical floor plan for a large meter repair shop). Available without cost or obligation. WRITE today for this chart.

BADGER METER MFG. CO.
Milwaukee 10, Wisconsin

BRANCH OFFICES:
New York City • Philadelphia • Worcester, Mass. • Savannah, Ga. • Cincinnati • Chicago Kansas City, Mo. • Waco, Texas Salt Lake City, Utah • Portland, Ore. • Seattle, Wash. • Los Angeles

You will find a Badger Meter size and type for every waterworks service. Shown here are Model SC-SOT (for warm climates), and Model A-SOT (for cold climates) . . . sizes ⅝" to 1¼" . . . other models in sizes up to 12". Write for complete information and prices.

BADGER Water METERS

ACCURACY · LOW-COST MAINTENANCE · DURABILITY · SENSITIVENESS

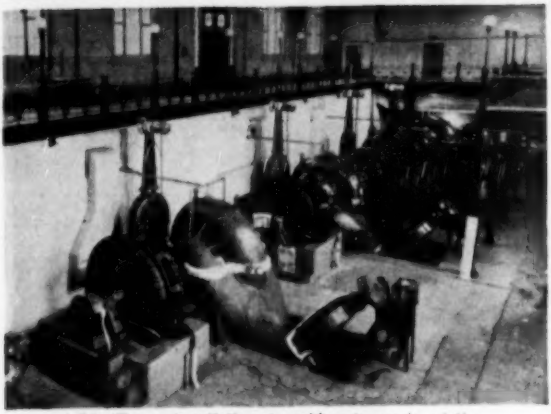
(Continued from page 4)

The unmentionableness of dowsing must again be modified, and again because eminent author Kenneth Roberts has adopted divination as his pet pastime. At last mention (P&R p. 8, Dec. 1948), Roberts had assured himself a place in the Ancient Annals of Rhabdomancy by achieving a spread in *Life* magazine for a dowser protege whose twig sought out not only water, but any beverage of any proof, and was able, as well, to give accurate predictions of the outcome of such crucial matters as the World Series and the cold war. Now, the author of *Northwest Passage* has turned south to do it again, taking his redoubtable dowser down to rain-barreled Bermuda to prove that its underground can produce more than the brackish brew hitherto therefrom exhumed. A dowse, a drill, an automatic pump, and, *presto*, from an underground spring some nineteen feet below sea level, 41 gpm. of fresh water that had all of Bermuda flocking to him with buckets, bottles and washtubs. And though our own doubts are not completely routed, we are not above wishing that Mister Roberts would stick to his fiction.

Lyle B. Porter is assuming the representation of Hungerford & Terry in the northern Illinois-eastern Iowa area.

(Continued on page 8)

LIMITORQUE ..for SAFE, DEPENDABLE operation of valves



A LimiTorque installation at a mid-west pumping station.

Limitorque operates by the "push of a button" from either remote or nearby control panel . . . prevents damage to stem, seat, disc, gate or plug, because Torque Seating Switch limits the torque and thereby shuts off the motor before trouble can occur . . . actuated by any available power source . . . fits all types of valves. LimiTorque may be obtained through valve manufacturers.

Write for catalog on your Business Letterhead, please.

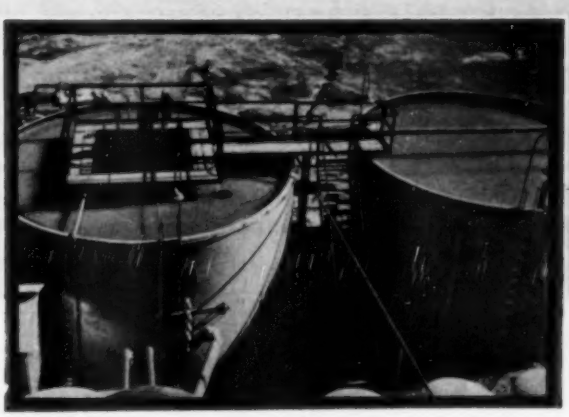
PHILADELPHIA GEAR WORKS, Inc.
ERIE AVENUE and G STREET, PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON
In Canada: William and J. G. Greey Limited, Toronto

COCHRANE

SLUDGE CONTACT REACTORS

For the Clarification of Water and the Recovery of Waste in Process

COCHRANE's specialization in the conditioning of industrial water supplies over the past fifty years and the combined years of experience of Cochrane engineers in that field, is your assurance of satisfactory service from any Cochrane installation. In the new method of sludge contact or removal by flocculation of impurities, turbidity, color or hardness, the Cochrane Sludge Contact Reactor accomplishes all these functions with complete efficiency and surprising economy. A new bulletin, Publication 5001, is available and will be sent on request.



Cochrane Sludge Contact Reactors are applicable to municipal and industrial plants for coagulation and/or softening, removal of turbidity, color, hardness, taste, for fluoride removal, de-alkalization, iron and manganese removal, etc.

COCHRANE CORPORATION

3124 N. 17th Street Philadelphia 32, Pa.

(Continued from page 6)

More than $350,000 in back wages was found by the U.S. Dept. of Labor to be due to employees of heat, light, power and water utilities under the Fair Labor Standards Act—the federal wage-hour law—in the last fiscal year, and amendments made effective in January, including the increase of the minimum wage from 40¢ to 75¢ an hour, make examination of the act's provisions even more important to the utility executive. Public utilities come under the scope of the law because they provide essential services to industries which are engaged in interstate commerce. In making a change in the wording of the Act, the Congress specifically mentioned water and other utilities supplying covered industries as being themselves subject to the act. As in the past, overtime at time-and-a-half rates for more than 40 hours a week is provided, although administrative, professional and certain other white-collar workers are exempted. Child-labor restrictions become compulsory under the new amendments.

The Pennsylvania Water Works Operators' Assn. is scheduled to hold its 23rd Annual Conference at State College on August 21, 22 and 23.

Ormond Burke, chief of the Bureau of Water Registry in New York City's Dept. of Water Supply, Gas and Electricity, died on April 14 at the age of 61. He had joined the department as an inspector 35 years ago, and was appointed to the post he has held for the last four years after having held that of chief inspector previously. His work entailed supervision of almost 300 inspectors and the prevention of improper uses of water, the difficulties of which had greatly increased as a result of the city's current water shortage.

Francis I. Kemp, manager of the Vertical Turbine Pump Div. of Worthington Pump and Machinery Corp., died suddenly on April 14. He had been with the organization since 1913, when he became a salesman in the St. Louis area. He had held his last post since 1944.

(Continued on page 10)

SUBMERGED PIPE LINE CONSTRUCTION

BOYCE COMPANY

Phone 3-2530 **Clearwater, Fla.**

HYDRO-TITE

WHEN YOU WENT COURTING . .

A pair of "Bull Dogs" like these and a three-inch starched collar were standard equipment. Probably a sailor straw with a gaily striped band rounded out the ensemble.

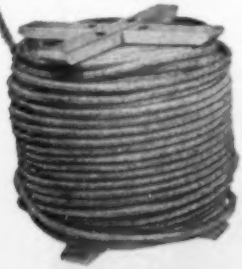
Even back in those days HYDRO-TITE was doing its job of making joints in cast iron water mains that were being laid away for keeps.

Styles have changed but HYDRO-TITE is still doing its job. Those joints are right there serving you twenty-four hours a day.

HYDRO-TITE is still made in powder form packed in 100-lb. moisture-proof bags, and now is obtainable also in "LITTLE-PIG" solid form in 50-lb. cartons.

Let HYDRO-TITE go to work for *you*.

PROTECT YOUR MAINS BY USING
FIBREX
THE BACTERIA FREE JOINT PACKING.



HYDRO-TITE AND FIBREX IN STOCK IN

Portland, Oregon	Seattle, Wash.
Kansas City, Mo.	Memphis, Tenn.
Birmingham, Ala.	Orlando, Fla.
Little Falls, N. J.	Boston, Mass.

HYDRAULIC DEVELOPMENT CORP.
MAIN SALES OFFICE **50 CHURCH ST., N. Y. C.**
General offices and works **W. Medford Sta., Boston, Mass.**

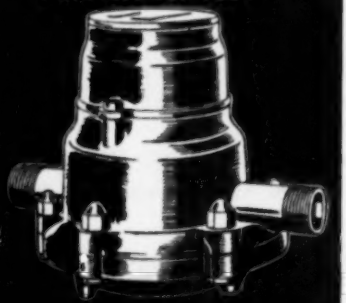
(Continued from page 8)

Carl N. Brown, western sales manager for U.S. Pipe & Foundry Co. at Chicago, and for some years secretary-treasurer of the Illinois Section, has been appointed assistant general sales manager of the company with headquarters at Burlington, N.J., effective July 1. Other changes in the company's sales staff which will be made simultaneously include the assignment of Howard A. Hoffer, assistant general sales manager, in his present capacity and location at Burlington headquarters, to handle all export and eastern division sales; the advancement of J. Leslie Hart from assistant to full western sales manager at Chicago; and the appointment of Harry D. Wade, Kansas City sales agent, to assistant western sales manager at Chicago.

A. E. Williamson Jr., Daytona Beach, Fla., consultant with Russell & Axon and secretary of the Florida Section, has accepted a post with the U.S. Public Health Service as water and sewerage consultant under the ECA program. He will be stationed in Athens, Greece, for a two-year period. Marvin R. Boyce of the Boyce Co., Clearwater, has been named acting secretary of the section.

(Continued on page 14)

SIMPLICITY of American Meters PAYS OFF for You!



Buffalo AMERICAN Meters are simply designed, with fewer working parts — save money for you through lower maintenance and replacement costs. Write for details.

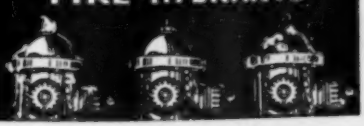
BUFFALO METER COMPANY
2914 Main Street
Buffalo 14, New York

It Is Easy To Switch Cigarettes But Not Fire Hydrants

A fire hydrant installation must serve for years. Don't make your decision until you get full specifications of the Kupferle line . . . the Fire Hydrant that has served with distinction for more than a half century.

JOHN C. KUPFERLE FOUNDRY CO.
ST. LOUIS

KUPFERLE
FIRE HYDRANTS



Teddy Roosevelt was president when we cleaned Washington's mains in 1907
1945 — National begins a 5 year job
Cleaning controlled by 2-way radio
NATIONAL CLE
GAN
umping costs
increases water pressure
FOR WASHINGTON, D. C.
Before cleaning
After cleaning

Way back in 1907 and again in 1926 National successfully cleaned the water mains of Washington, D. C.

In 1945 a five year program to clean and recondition the entire water main system of Washington was begun and National in conjunction with the Centriline Corporation was again awarded the cleaning contract for 1945, 1946, 1947, 1948 and 1949 — *in short, the entire cleaning job!*

Tests made on those lines already cleaned and centrilined indicate a co-efficient of over 130 as against less than 90 before cleaning, resulting in lower pumping costs, increased volume and higher pressure.

Let us estimate the cost of restoring your lines to at least 95% of their original carrying capacity. Write today.

NATIONAL WATER MAIN CLEANING COMPANY 29

50 Church Street, New York 7, N. Y.

ATLANTA, GA., 333 Candler Bldg. & P. O. Box 9—Station E • BOSTON, 115 Peterboro St. • CHICAGO, Room 1336, S. Michigan Ave. • KANSAS CITY, MO., 406 Merchandise Mart, 2201 Grand Ave. • LOS ANGELES, 448 S. Hill Street • LITTLE FALLS, N. J., Box 91 • OMAHA, 3812 Castellar Street • RICHMOND, 210 East Franklin Street • SPRINGFIELD, MO., 1301 Prospect Ave. • SALT LAKE CITY, 149–151 W. Second So. Street • SAN FRANCISCO, 681 Market St. • SIGNAL MT., TENN., 204 Slayton Street • FLANDREAU, S. D., 315 No. Crescent St. • MONTREAL, 2028 Union Ave. • VANCOUVER, B. C., 505 West 1st Avenue • WACO, P. O. Box 887 • WINNIPEG, 576 Wall St. • HAVANA • SAN JUAN, PUERTO RICO • BOGOTA • CARACAS • MEXICO CITY.

HOW Prestressed Concrete Steel-Cylinder Pipe

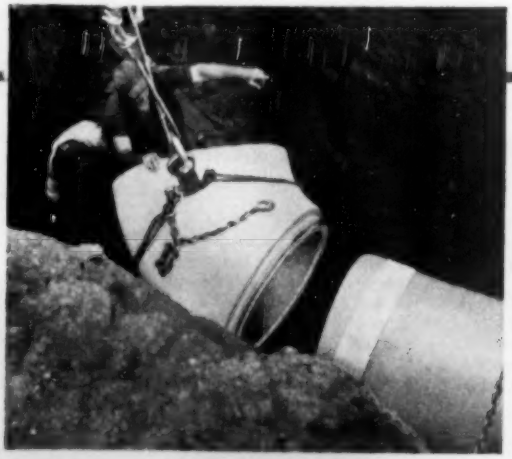
Three materials are used in the manufacture of Prestressed Concrete Steel-Cylinder Pipe . . . sheet steel, high tensile steel wire, and concrete. Each contributes qualities found in no other material to produce a *combination of advantages found in no other pipe.*

1. A STEEL CYLINDER . . .

is formed and hydrostatically tested up to a tension in the steel of 25,000 psi. (Steel cylinder provides high beam strength and water tightness.)

This combination produces water pressure pipe that will give the longest trouble-free service at the lowest cost. That's why Prestressed Concrete Steel-Cylinder Pipe was picked for one of America's *longest* high-pressure water supply pipe lines—the Saginaw-Midland pipe line in Michigan, and for lines in Miami, Fla., Rochester, N. Y. and elsewhere. Prestressed Pipe is available in sizes from 16″ up for any pressure common to American water-works practice.

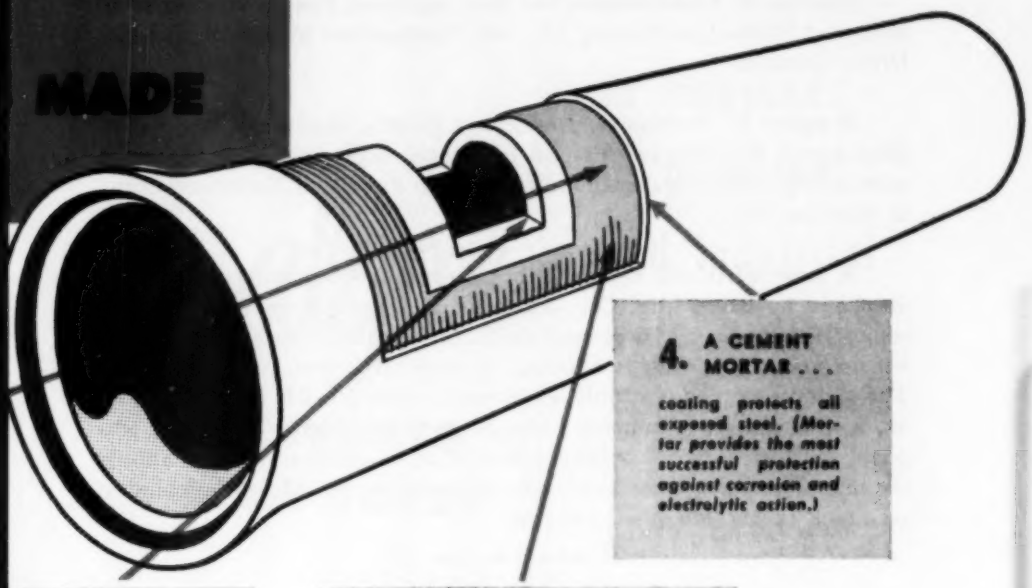
Our engineers know pipe line design and laying problems. Consult them. There will be no obligation.



Installing Price Brothers Prestressed Pipe on the 80-mile Saginaw-Midland project, one of America's longest high-pressure water supply pipe lines. Elbows go into line easily and quickly.

Prestressed Pipe provides longest *trouble-free* service at the lowest cost.

MADE



4. A CEMENT MORTAR . . .

coating protects all exposed steel. *(Mortar provides the most successful protection against corrosion and electrolytic action.)*

2. A CONCRETE CORE . . .

is formed inside the steel cylinder. This becomes a structural part of the pipe. *(Concrete lining provides initial and continued high rate of flow.)*

3. HIGH TENSILE STEEL WIRES . . .

are wound around the steel cylinder and concrete core at constant tension. *(Steel wire prestresses steel cylinder and concrete core by compressing them. Compression is relieved as internal water pressure increases, thus permitting high operating pressures without tension in concrete.)*

PRICE Pressure PIPE

PRESTRESSED CONCRETE STEEL-CYLINDER PIPE

Price Brothers Company

1750 EAST MONUMENT AVENUE, DAYTON 1, OHIO

Send for these fact-packed booklets on Price Brothers Prestressed Concrete Steel-Cylinder Pipe.

Please send me information on Prestressed Pipe.

- ☐ Manufacturing and Prestressing
- ☐ Tapping under Pressure
- ☐ AWWA Specification No. 78.2-T

NAME _____

TITLE _____

ORGANIZATION _____

ADDRESS _____

(Continued from page 10)

Thomas F. Charbonneau has been appointed Florida representative of Graver Water Conditioning Co., with headquarters at 305 W. Colonial Drive, Orlando.

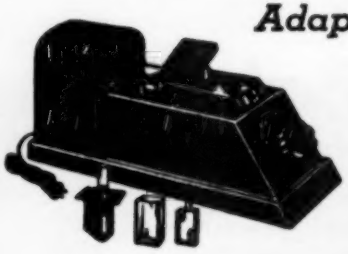
Walther H. Feldmann, president of Electric Machinery Mfg. Co. of Minneapolis, has resigned his post to become vice president in charge of sales for the parent organization, Worthington Pump and Machinery Corp., at Harrison, N.J.

A new earth fill tamper—the Barco Pegson Rammer—has been developed by Barco Mfg. Co. The unit is designed to give high degree compaction in restricted areas and should find its maximum use for tamping when construction work is adjacent to other structures, pipes and walls. The high penetration it affords is claimed to make possible lifts of 12 to 20 in., with a capacity of tamping 10 to 24 cu.yd. per hour. The thrust of a power cylinder, actuated by combustion of an oil-gasoline mixture, affords the motive power. Over two hours of operation are said to be obtained on a tank (about two quarts) of fuel.

(Continued on page 16)

KLETT SUMMERSON
ELECTRIC PHOTOMETER

Adaptable for Use in Water Analysis



Can be used for any determination in which color or turbidity can be developed in proportion to substance to be determined

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179 EAST 87th STREET · NEW YORK, N. Y.

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*T.M. Reg. U.S. Pat. Off.

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CALGON* prevents lime scale

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Hagan Building, Pittsburgh 30, Pa.

Please send me your bulletin, "Calgon Prevents Lime Scale."

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Position_____

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Street and Number_____

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J-6

(Continued from page 14)

An improved automatic vent and drain valve has been developed by Crane Co. to insure more accurate seating and longer life. The valve uses a simplified ball-type seating mechanism instead of the customary disc.

Carter Products Corp., producer of the Carlon pipe advertised on the facing page, advise that purchasers should specify Carlon "EF" pipe for potable water service. An otherwise similar pipe—Carlon "E"—cannot be used to carry liquids intended for human consumption.

Marshall E. Cusic has been appointed district sales engineer of Chain Belt Co. for the Pittsburgh district, with headquarters at 1101 Grant Bldg., Pittsburgh 19, Pa.

Gene D. Sickert has been appointed works manager of the Peerless Pump Div. Indianapolis plant. He had held a similar position with Bolens Product Div.—another division of Food Machinery and Chemical Corp.—previously.

(Continued on page 18)

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3 *Money, Time and Labor Saving Features of*

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CAST IRON PIPE

LAID WITH ONLY WRENCHES

NO CAULKING MATERIALS

NO GASKETS. NO BELL HOLES TO DIG.

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For water supply, fire protection systems, sewage disposal systems, industrial, and irrigation. Flexible.

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Easy to operate at LOW MAINTENANCE COST.
Everson SterElatorS METER-MIX-FEED Chlorine accurately for all water sterelising requirements. Furnished for manual or automatic operation.
Everson SterElatorS utilize a high vacuum. The indicating FLOW METERS have a 10 to 1 ratio.

SterElatorS by Everson

EVERSON MANUFACTURING CORPORATION
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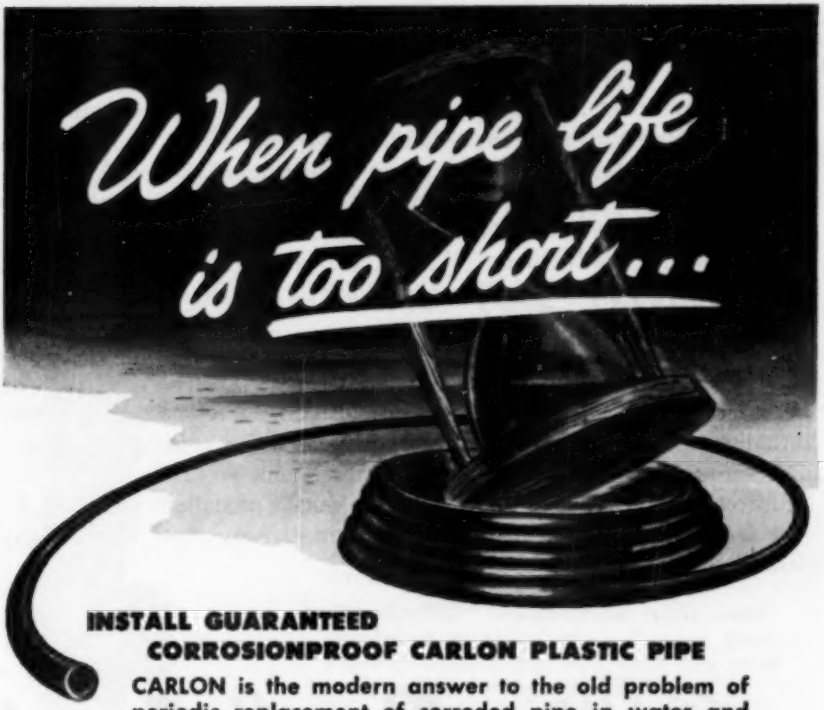

INSTALL GUARANTEED
CORROSIONPROOF CARLON PLASTIC PIPE

CARLON is the modern answer to the old problem of periodic replacement of corroded pipe in water and sewage lines. This remarkable new plastic pipe is guaranteed forever against rot, rust, and electrolytic corrosion. It has a projected service life more than double that of ordinary pipe, even under the most severe conditions.

Flexible and extremely light in weight, CARLON is easier and more economical to install. Long sections can be handled by one man, who can lay the pipe and then make joints in two minutes. In addition, many fittings necessary for ordinary pipe are completely eliminated.

CORROSIONPROOF • LIGHT WEIGHT • FLEXIBLE

These features make CARLON PLASTIC PIPE the outstanding water transmission development of the century.

Write today for additional information, or call BRoadway 6565 for immediate service.

CHECK CARLON SIZES • • LENGTHS • • WEIGHT • • STRENGTH

STD. SIZE	O. D.	I. D.	CALCULATED B. P. P. S. I.	WT./FT.	NORMAL SHIPPING LENGTHS
1/2"	0.840	0.622	540 lb.	0.103 lb.	400 ft. coils
3/4"	1.050	0.824	350 lb.	0.140 lb.	400 ft. coils
1"	1.310	1.070	200 lb.	0.181 lb.	300 ft. coils
1 1/4"	1.660	1.380	200 lb.	0.267 lb.	300 ft. coils
1 1/2"	1.900	1.610	200 lb.	0.320 lb.	250 ft. coils
2"	2.378	2.070	170 lb.	0.445 lb.	200 ft. coils
3"	3.504	3.070	165 lb.	0.91 lb.	100 ft. coils
4"	4.504	4.030	150 lb.	1.25 lb.	25 ft. str.
6"	6.630	6.070	115 lb.	2.23 lb.	25 ft. str.

CARLON CP

CARTER PRODUCTS CORPORATION
10126 MEECH AVENUE
CLEVELAND 5, OHIO

(Continued from page 16)

Robert E. Stiemke, professor of sanitary engineering at Pennsylvania State College, will become director of the School of Civil Engineering, Georgia Institute of Technology, on September 1. He had previously held faculty posts at North Carolina State College and Wayne University, in addition to a consulting connection with Hubbell, Roth and Clark and posts with the U.S. Public Health Service during the war and the Corps of Engineers before it. He is currently Secretary-Treasurer of the Pennsylvania Water Works Operators' Assn., and has been an active force in the short schools for water and sewage works held annually at State College.

A photoelectric recording turbidimeter which gives continuous readings of turbidity in water has been developed by General Electric Co., Schenectady 5, N.Y. Because its operation is based on the principle that turbidity varies in proportion to the ratio of scattered light to transmitted light through a liquid, the instrument measures only this ratio and will not be affected by changes in liquid color or voltage variations affecting the light source used. The range of the instrument may be set to cover any desired scale, with adjustable sensitivity.

(Continued on page 22)

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Ferri-Floc
FERRIC SULPHATE
Atlanta, Georgia

Results Count

• MORE ECONOMICAL • EASIER TO HANDLE
• SUPERIOR RESULTS

The use of Ferri-Floc in water supplies has several advantages over other coagulants now in use. Economy of operation is a great factor in the minds of prospective users, but, once used Ferri-Floc immediately shows its ability to produce a higher quality of water at a lower cost.

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1. Coagulation is effective over a much wider pH range than with alum. Color flocs may be formed in the very acid range, where alum may not be employed. On the other hand, true hydrated ferric oxide flocs may be formed at pH 9-10, or even higher for the removal of turbidity and manganese.
2. The time required for floc formation, conditioning, and settling is in many cases considerably shorter than that required for other coagulants.
3. Filter runs have been markedly increased in several cases.
4. Manganese is successfully removed at pH values above 9.
5. Effluents may be produced which are exceedingly low in both iron and aluminum.
6. Hydrogen sulfide is removed, and taste and odor improved.
7. Ferric floc does not seem to stick to sand grains to form mud balls, and is subject to less "breaking through" on the filters.

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Atlanta, Georgia Lockland, Ohio

More than a Million LUDLOW HYDRANTS are Landmarks of Security!

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To inspect or service a Ludlow Slide Gate Hydrant you'll need a wrench—that's all. Just take off the top of the hydrant and lift out the stem, *without unscrewing anything below ground.* The entire mechanism, including the gate, bronze wedge nut and drip assembly is attached to the stem.

LUDLOW FIRE HYDRANTS

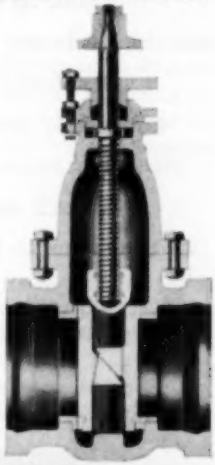
Shown here is the distinctive Ludlow List No. 90, now serving in thousands of cities and towns. It employs the famous Ludlow Slide Gate principle, and (in addition to easy servicing) offers the following advantages:

- ***Quick Water*** **with least possible shock and pressure loss. Proper shut-off without water hammer.**
- ***Proper Drainage,*** **automatically, at lowest point when closed.**
- ***No Flooding.*** **Wedge-locked when closed. Accidental breaking will not cause flood. Hydrant head breaks at ground line — is easily replaced without excavation.**

LUDLOW AWWA DOUBLE DISC GATE VALVES

The parallel seated, double wedge type slide gate valve, developed and perfected by Ludlow, provides a number of essential benefits.

- ***Smooth, Positive Operation.*** **Gates positioned directly opposite ports before wedging, and entirely unwedged before being raised.**
- ***Positive Closure.*** **Even after years of service in the open position; flexible-action gates self-adjusting to seats.**
- ***Simplicity!*** **Only 2 parts in the wedging mechanism! These are extra heavy with ample reserve strength and wear resistance for years of constant service.**



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The LUDLOW VALVE MFG·CO·INC·TROY·N·Y· SINCE 1866

Without shock strength—or, for that matter—without all of the strength factors listed opposite—no pipe laid 100 years ago in *city streets* would be in service today.

But, in spite of the evolution of traffic from horse-drawn vehicles to heavy trucks and buses—and today's vast complexity of subway and underground utility services—cast iron gas and water mains, laid over a century ago, are serving in the streets of more than 30 cities in the United States and Canada.

Such service records prove that cast iron pipe combines all the strength factors of long life with ample margins of safety.

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets.

Cast Iron Pipe Research Association,
Thos. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3.

CAST IRON PIPE

Strength factors of Long Life !

No pipe that is provably deficient in any of these strength factors should ever be laid in city streets

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

CRUSHING STRENGTH

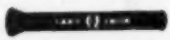
The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.



SERVES FOR CENTURIES

(Continued from page 18)

An analysis of the public water works construction program in Florida, as prepared by the State Board of Health, indicates that during the four-year period 1946–1949, 81 municipal projects were built at an estimated cost of over $12,000,000. Of these, 53 projects representing more than three-fourths of the cost involved plants and additions; the remainder were distribution systems and extensions. Projects of other subdivisions totaled 54 during the same period, and brought the grand total of estimated cost to $12,795,869.

In addition to the completed projects, plans were approved in 1949 for fourteen municipal construction programs—eight involving plants and additions and six involving distribution systems. The projects are expected to cost over $6,000,000. All plans were approved by the Florida State Board of Health.

A revision to the "American Standard Safety Code for Identification of Gas-Mask Canisters"—the first in 20 years—specifies a color scheme for marking canisters intended for protection against chlorine gas. Copies of the code (K13.1–1950) are available from ASA, 70 E. 45 St., New York 17, at 35¢ each.

John W. Mantz, industrial relations manager at the Painesville, Ohio plant of Diamond Alkali Co., has been appointed assistant general manager of the plant. Mantz joined the Diamond staff four years ago, after over 20 years with Mathieson Chemical Corp.

A new model Hydrauger earth boring tool has been developed by Hydrauger Corp., Ltd., 681 Market St., San Francisco, Calif. Rapid drilling of 2- or 2½-in. holes using air and water is claimed for the machine, which is only 8 in. wide and weighs 150 lb. Hollow boring bars with $1\frac{3}{16}$ in. diameter, through which service pipe can be drawn for installation, are used.

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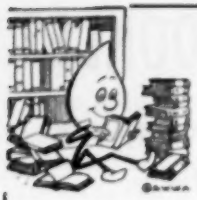

The Reading Meter

Chemical Engineers' Handbook. *John H. Perry, ed. McGraw-Hill Book Co., New York (3rd ed., 1950) $15.*

An exhaustive revision of previous editions, this work features much fresh material and an enlarged size (7½ by 9½ in.) for its close to 2,000 pages which takes it out of the "handbook" class in all but name. Among the sections which have been heavily revised or which are new are those on flow of fluids, spray ponds and cooling towers, accounting and cost finding and movement and storage of materials. Numbers denoting each of the volume's 30 major sections are thumb-indexed to facilitate reference, and so is the index itself. A staff of over 140 specialists are responsible for the wealth of informative material contained.

Groundwork for Action. *Morris Llewellyn Cooke et al. No. 3 in "Bold New Program" Series. The Public Affairs Institute, Washington, D.C. (1950) 50¢.*

This paperbound book, the third of eight studies on the potentialities and problems of President Truman's Point Four program for technical aid to underdeveloped lands, is concerned with the area-by-area needs and opportunities for American engineers, technicians and investors in implementing the program. It also outlines and estimates the cost of plans for setting the plan in motion. The senior author is chairman of the President's National Water Policy Commission.

Simplified Municipal Accounting: A manual for smaller governmental units. *Municipal Finance Officers Assn., Chicago (1950)* $3.25.

This little volume of only 162 pages, prepared by the society which, together with A.W.W.A., is responsible for the *Manual of Water Works Accounting*, is intended for the smaller community. It contains a review of fundamental accounting principles and describes, with illustrative tables, examples and printed forms, the necessary accounting statements and records, the accounts themselves, journal entries, and budgets. A chapter on public utility accounting is included.

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Membership Changes

NEW MEMBERS

Applications received April 1 to 30, 1950

Adair, Duncan L., Supt., Public Works, 28 Pearl St., Sidney, N.Y. (Jan. '50) *MP*

Adams, C. Donald, *see* San Antonio Water Co.

Advance Munic. Water Utility, Richard D. Caldwell, Supt., Advance, Ind. (Corp. M. Apr. '50) *M*

Alexandria Board of Public Works, James L. Rudd, Supervisor, Water Dept., Alexandria, Minn. (Munic. Sv. Sub. Apr. '50) *MP*

American Oil & Supply Co., Edgar F. Hoffman, Vice-Pres. & Treas., 238 Wilson Ave., Newark 5, N.J. (Assoc. M. Apr. '50)

Anderson, Felix A., Partner, Clark, Johnson & Anderson, 713 Community National Bank Bldg., Pontiac, Mich. (Apr. '50) *MP*

Arp, Robert S., Supt., Water Treatment Plant, Adair Village, State Board of Higher Education, Corvallis, Ore. (Apr. '50)

Ballard, Lawrence L., Asst. Engr., Field Constr., Washington Suburban San. Com., Hyattsville, Md. (Apr. '50)

Barney, A. C., Indus. Sales Engr., Crane Co., 624 E. 1st St., Wichita, Kan. (Apr. '50) *M*

Barron, Donald Wyant, Pres. & Engr., Albert F. Ganz, Inc., 511—5th Ave., New York 17, N.Y. (Apr. '50) *M*

Berry, W. R., Supt., Water Dept., Valley Center, Kan. (Apr. '50) *M*

Biggs & Co., J. E. Biggs, Pres., 1401-03 Lamar St., Box 179, Wichita Falls, Tex. (Assoc. M. Apr. '50)

Biggs, J. E., *see* Biggs & Co.

Blakely, Jones Hoyt, Jr., Asst. Chemist, Union Bleachery, Box 900, Greenville, S.C. (Apr. '50) *P*

Blomgren, Carl Virgil, Public Health Engr., State Dept. of Health, 544—5th Ave., Council Bluffs, Iowa (Apr. '50) *P*

Bolgrien, Alvin F., Dist. Mgr., Wisconsin Power & Light Co., Beloit, Wis. (Apr. '50) *MPR*

Bremerton Water Dept., D. B. Wheaton, Comr. of Public Works, City Hall, Bremerton, Wash. (Corp. M. Apr. '50)

Briley, Harold D., Vice-Pres., Briley, Wild & Assoc., Cons. Engrs., 8 N. Wild Olive, Daytona Beach, Fla. (Apr. '50) *PR*

Brown, Wayne T., Water Inspector, Northern Pacific Ry. Co., Livingston, Mont. (Apr. '50) *PR*

Burns, Fred R., Head Power Plant Operating Engr., Dept. of Water Supply, 10100 E. Jefferson Ave., Detroit 14, Mich. (Jan. '50) *M*

Caldwell, Richard D., *see* Advance Munic. Water Utility

Carpenter, Charles L., Sales Engr., Ingersoll-Rand Co., 1460 E. 4th St., Los Angeles 33, Calif. (Apr. '50) *M*

Chastain, Homer Leon, Supt., Munic. Water Works, County Bldg., Decatur, Ill. (Apr. '50) *M*

Cochrum, G. Wesley, Meter Shop Foreman, Water Dept., 812 E. 15th St., Winfield, Kan. (Apr. '50) *M*

Cole, James Waugh, Water Chemist, Baltimore & Ohio R.R., Mt. Clare, Baltimore 23, Md. (Apr. '50) *P*

Collins, George M., *see* Honolulu Board of Trustees

Crossley, Alfred, Jr., Owner, Culligan Soft Water Service Co., 510 Central Ave., Fairbault, Minn. (Apr. '50) *P*

Cuevas, Sergio, *see* Puerto Rico Aqueduct & Sewer Authority

Daley, John J., City Engr., Cut Bank, Mont. (Apr. '50)

Dietrick, John A., Treas. & Gen. Mgr., Northern Cambria Water Co., 3704 N. 2nd St., Harrisburg, Pa. (Apr. '50) *M*

(*Continued on page 32*)

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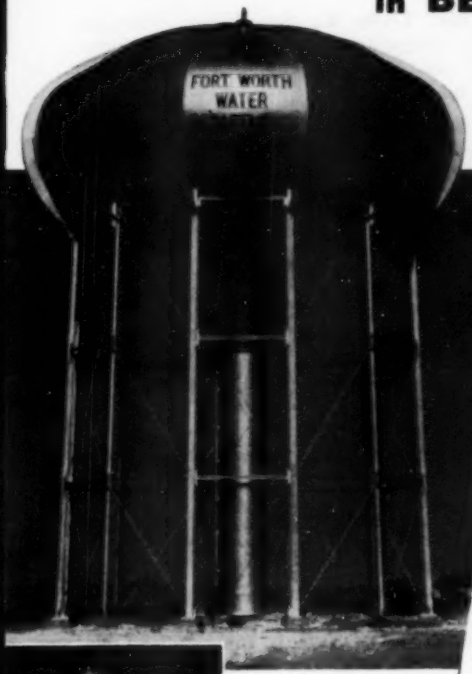

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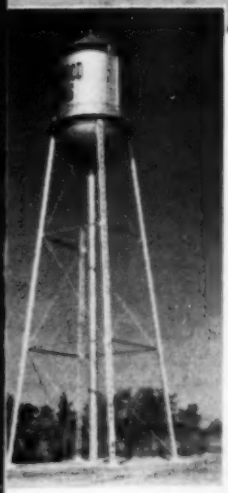

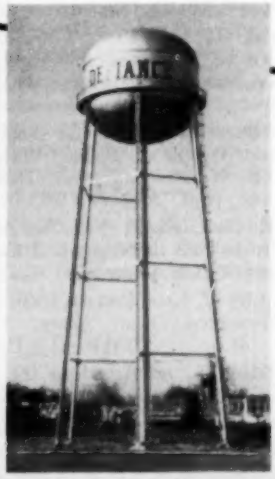

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(*Continued from page 30*)

Duffy, J. T., Jr., Contractor & Sales Repr., United Eng. Co., c/o Hotel Antlers, Indianapolis, Ind. (Apr. '50) *P*

Eller, Dwane I., Chief Operator, City Water Plant, Junction City, Kan. (Apr. '50) *P*

Etcheson, Clarence, *see* Jamestown, Town of

Fredendall, Mercer W., Mgr., R. W. & B. P. Sanders, Inc., 336 W. 2nd St., Claremont, Calif. (Apr. '50) *M*

Gardner, J. R., Asst. Engr., Warren & Van Praag, Inc., 253 S. Park St., Decatur, Ill. (Apr. '50)

Garnell, Michael A., San. Chemist, Dept. of Water Supply, Filtration Plant, Water Works Park, Detroit, Mich. (Apr. '50) *P*

Gaudry, Edwin, Mfrs. Agent, Stanton Ironworks, 75 St. Louis St., Quebec, Que. (Apr. '50)

Grossman, Irving, Student, Johns Hopkins Univ., Dept. of San. Eng. Baltimore 18, Md. (Jr. M. Apr. '50) *PR*

Gundershaug, John N., Supt. of Utilities, City Hall, Alexandria, Minn. (Apr. '50) *MP*

Hardin, L. G., Machinery Dealer, 2409 Myrtle St., Alexandria, La. (Apr. '50)

Harris, John S., Instructor, Filtration Plant Operator, U.S. Penitentiary, McNeil Island, Box 250, Steilacoom, Wash. (Apr. '50)

Hartzell, William Robert, Water Treatment Plant Operator, Munic. Water Works, 210 N. Romona Ave., Hawthorne, Calif. (Apr. '50) *P*

Helmers, E. Neil, Engr., Eng. Service Div., E. I. du Pont de Nemours & Co., Wilmington 98, Del. (Apr. '50)

Herington, City of, Enos Purcell, Utilities Supt., Herington, Kan. (Corp. M. Jan. '50) *M*

Hoffman, Edgar F., *see* American Oil & Supply Co.

Hoge, John C., *see* Lafayette, City of

Holdsworth, K. G., Chairman, Water Works Committee, Corp. of Town of Milton, Milton, Ont. (Apr. '50)

Honolulu Board of Trustees, George M. Collins, Pres., Bernice P. Bishop Estate, Box 3466, Honolulu 1, Hawaii (Corp M. Apr '50)

Ide, Leslie E., Secy.-Treas., Tart-Ide Corp., 13118 Wayzata Blvd., Minneapolis 16, Minn. (Apr. '50) *P*

Inbody, Wayne, Chem. Engr., Diamond Alkali Co., Tech. Service Div., Painesville, Ohio (Apr. '50) *P*

Jakaitis, B. L., Supt., Water Works, North Chicago, Ill. (Apr. '50)

Jamestown, Town of, Clarence Etcheson, Supt., Water Works, Jamestown, Ind. (Corp. M. Apr. '50) *M*

Johnson, Russell L., Engr. in Charge, Northern Peninsula Office, State Dept. of Health, Escanaba, Mich. (Apr. '50) *MP*

Johnson, William Duke, Owner, Culligan Soft Water Service, 799 Market St., Meadville, Pa. (Apr. '50)

Johnston, Donald Percy, Supt., Water Dept., Bangor, Me. (Apr. '50) *M*

Jorgensen, Alfred W., Asst. Supt., Crescenta Mutual Water Co., 3730 Glenwood Ave., Verdugo City, Calif. (Apr. '50) *M*

Kiger, Leon, Mgr., Water Works Utility, Bourbon, Ind. (Apr. '50) *M*

Klenda, Theodore J., Indus. Sales Engr., Crane Co., 624 E. 1st St., Wichita, Kan. (Apr. '50) *P*

Korthauer, Armin W., Water Supt., 120 Garden St., Bensenville, Ill. (Apr. '50)

Kubitschek, Ray, Salesman, Salina Supply Co., 302 N. Santa Fe, Salina, Kan. (Apr. '50)

Lafayette, City of, Utilities System, John C. Hoge, Mgr., City Hall, Lafayette, La. (Munic. Sv. Sub. Apr. '50) *MP*

Landis, William Richard, Partner, Sergeant & Landis, 309 United Office Bldg., Niagara Falls, N.Y. (Apr. '50) *PR*

Langston, C. E., *see* Mission, City of

Leoti, City of, Oliver Strecker, Water Supt., Leoti, Kan. (Munic. Sv. Sub. Apr. '50) *M*

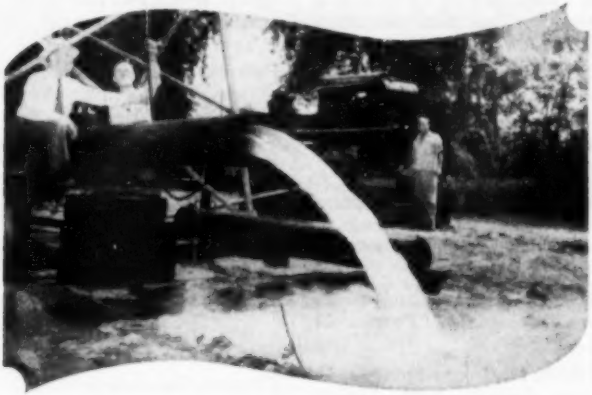
Litchfield, City of, Utilities Dept., William E. Steinberg, Head of Water Dept., 310 Armstrong, S., Litchfield, Minn. (Munic. Sv. Sub. Apr. '50) *MP*

Lucas, Joseph, *see* Spring Valley, City of

Lucker, Le Roy V., Chemist, Water Plant, Great Falls, Mont. (Apr. '50) *P*

Maneri, Charles Salvatore, Jr. San. Engr., State Dept. of Health, 510 Terminal Bldg., Rochester 14, N.Y. (Apr. '50) *PR*

(*Continued on page 34*)



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McCandless, Lee, Meter Repairman, Hersey Mfg. Co., 1812 Hermosa Drive, Temple City, Calif. (Apr. '50) *M*

McDaniel, L. A., Water Supt., Wetmore, Kan. (Apr. '50) *M*

McDonald, Hayward C., City Engr. & Supt. of Water System, 1091—5th St., Napa, Calif. (Apr. '50)

McLaughlin, W. J., Draftsman, Dept. of Transport, Air Services Branch, 3 Temporary Bldg., Wellington St., Ottawa, Ont. (Affil. Apr. '50)

McNeely, Harry R., Jr., Utilities Engr., Caterpillar Tractor Co., Peoria, Ill. (Apr. '50) *MPR*

Mearns, William, III, Engr., Standard Oil Development Co., Box 121, Linden, N.J. (Apr. '50) *MPR*

Meier, E. Bruce, Asst. Prof. of Civ. Eng., Univ. of Nebraska, Lincoln, Neb. (Apr. '50) *PR*

Metcalf, Ralph L., Engr., Russell & Axon, Municipal Airport, Daytona Beach, Fla. (Apr. '50) *P*

Mission, City of, C. E. Langston, Water Supt., 1101 Conway Ave., Mission, Tex. (Corp. M. Apr. '50) *MP*

Montgomery, Kenneth Hugh, Supt., Corp. of City of Kimberley, City Hall, Kimberley, B.C. (Apr. '50) *M*

Moyer, J. F., Distr. Foreman, Water Dept., Junction City, Kan. (Apr. '50) *M*

Mraz, Frank J., Village Mgr., 137th St. & Wabash Ave., Riverdale, Ill. (Apr. '50) *M*

Munson, Allen S., Water Supt., Water Works, McGregor, Tex. (Jan. '50) *M*

Nay, Glenn O., *see* Shafter Public Utility Dist.

Neese, L. Vincent, Salesman, Hersey Mfg. Co., 811 E. Morehead St., Charlotte, N.C. (Apr. '50)

Nickerson, Malcolm H., Engr., Factory Mutual Fire Insurance Cos., Eng. Div., 607 Sterling Tower, 372 Bay St., Toronto 1, Ont. (Apr. '50) *M*

Nicolson, Alexander Hamilton, Asst. Engr., Water Dept., Utility Bldg., Calgary, Alta. (Apr. '50)

O'Day, Leo, Supt., Water Works, Village of Mahtomedi, Route 9, St. Paul 10, Minn. (Apr. '50) *MP*

Oyler, Willie Forrest, Acting Director of Utilities, 1805 Chestnut, Colorado City, Tex. (Apr. '50) *MPR*

Palevsky, Gerald, Instructor in Civ. Eng., New York Univ., Civ. Eng. Dept., University Heights, New York 53, N.Y. (Apr. '50)

Palmer, Vernon John, Chief Engr., Bruner Corp., 2318 N. 30th St., Milwaukee 10, Wis. (Apr. '50) *MP*

Perry, Guy A., Supt., Water Works, Creston, Iowa (Apr. '50) *M*

Phillips, William Fred, Sales Engr., Byron Jackson Co., 2300 E. Vernon, Box 2017 Terminal Annex, Los Angeles, Calif. (Apr. '50)

Pittman, Claud, Supervisor, Water Works, McCaysville, Ga. (Apr. '50)

Polak, Louis, *see* Recording & Statistical Corp.

Poundstone, Arthur, *see* Rochester Water Dept.

Prescott, M. H., City Engr., Swift Current, Sask. (Apr. '50)

Proctor, G. E. M., Jr. Engr., Proctor, Redfern & Laughlin, 11 Jordan St., Toronto, Ont. (Apr. '50)

Puerto Rico Aqueduct & Sewer Authority, Sergio Cuevas, Exec. Director, Box 2832, San Juan, Puerto Rico (Corp. M. Apr. '50)

Purcell, Enos, *see* Herington, City of

Randall, Jacob S., Field Engr., State Water Survey Div., Box 1086, Joliet, Ill. (Apr. '50) *R*

Randall, Melvin Lee, Utility Officer, Water Dept., 422 W. Poplar, Olathe, Kan. (Apr. '50) *M*

Recording & Statistical Corp., Louis Polak, Mgr., Public Utilities, 100—6th Ave., New York 13, N.Y. (Assoc. M. Apr. '50)

Reich, Charles, Water Supt., Oak Lawn, Ill. (Apr. '50) *MR*

Rezanka, George C., Resident Chemist, Sinclair Refining Co., 3500 Indianapolis Blvd., East Chicago, Ind. (Apr. '50) *P*

Rice, G. Albert, Field Engr., Fischer & Porter (Canada) Ltd., 964 Eglinton Ave., Toronto 10, Ont. (Apr. '50)

Rieser, Douglas Alois, Asst. Engr., Chicago, Milwaukee, St. Paul & Pacific R.R. Co., 809 Union Station, Chicago, Ill. (Apr. '50) *MP*

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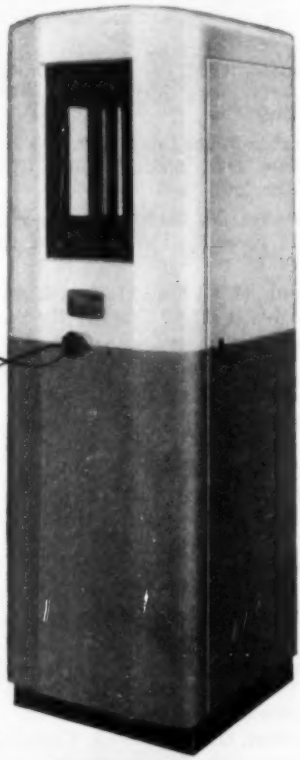

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Rochester Water Dept., Arthur Poundstone, Rochester, Ind. (Corp. M. Apr. '50) *MP*

Rudd, James L., *see* Alexandria Board of Public Works

Rude, Kermin, Supt. of Water Filtration, City Light & Water Dept., Granite Falls, Mont. (Apr. '50) *MP*

Rule, Ronald, Supt., Public Works, Batavia, Ill. (Apr. '50) *M*

San Antonio Water Co., C. Donald Adams, Mgr., 139 N. Euclid Ave., Upland, Calif. (Corp. M. Apr. '50) *M*

Schmaling, Ralph, Supt., Water Dept., 428 Jefferson St., Burlington, Wis. (Apr. '50)

Schultz, Carl J., Pres., Schultz-Forster Assoc., Inc., Burdett Bldg., Troy, N.Y. (Apr. '50) *P*

Shafter Public Utility Dist., Glenn O. Nay, City Hall, Shafter, Calif. (Corp. M. Apr. '50) *MR*

Sheaffer, M. Clyde, Attorney-at-Law, 17 N. Front St., Harrisburg, Pa. (Apr. '50) *M*

Smith, H. F., Engr., Illinois Water Survey Div., Box 232, Urbana, Ill. (Apr. '50)

Sneddon, Alexander Wilson, Asst. City Engr., Corp. of City of Vancouver, City Hall, Vancouver, B.C. (Apr. '50) *M*

Sortor, Charles H., Sales Mgr., Peerless Pump Div., Food Machinery & Chemical Corp., Fresno, Calif. (Apr. '50) *R*

Spring Valley, City of, Joseph Lucas, Supt. of Public Works, City Hall, Spring Valley, Ill. (Corp. M. Apr. '50) *MP*

Stallworth, B. E. R., Water Supt., 308 S. Rice St., Bellaire, Tex. (Apr. '50) *MP*

Steinberg, William E., *see* Litchfield, City of

Stenehjem, Julian Sidney, Field Engr., The Bristol Co., 253 Plymouth Bldg., Minneapolis, Minn. (Apr. '50)

Stewart, Ora D., Mayor, Grainfield, Kan. (Apr. '50)

Stivarius, A. F., Dist. Public Health Engr., State Board of Health, Municipal Bldg., Elkhorn, Wis. (Apr. '50)

Stone, Raymond V., Jr., Research San. Engr., San. Eng. Research Project, Univ. of California, Berkeley, Calif. (Apr. '50)

Strecker, Oliver, *see* Leoti, City of

Taylor, Harvey Walter, San. Engr., Div. of San. Eng., State Board of Health, Helena, Mont. (Apr. '50) *MP*

Venrick, Robert, Supt., Water Dept., Mechanicsburg, Ohio (Apr. '50) *M*

Vogel, Jacob Henry, Asst. Engr., Washington Suburban San. Com., Hyattsville, Md. (Apr. '50) *M*

Volkmann, Harold R., Supt. of Utilities, Light & Water Dept., Clay Center, Kan. (Apr. '50) *M*

Warner, Raymond A., Field Supt., Wayne County Metropolitan Water Dist., Wayne County Road Com., 3800 Barlum Tower, Detroit, Mich. (Apr. '50) *M*

Wellman, H. C., Supt., Water Dept., City Hall, Gladstone, Ore. (Apr. '50)

Westcott, Ralph M., Partner, Pomeroy & Westcott, 660 S. Fair Oaks Ave., Pasadena 2, Calif. (Apr. '50)

Wheaton, D. B., *see* Bremerton Water Dept.

Whiteside, William Minder, Sales Engr., Hersey Mfg. Co., 420 E. 3rd St., Los Angeles, Calif. (Apr. '50) *MPR*

Williams, Walter E., Student, Univ. of Minnesota, 145 Melbourne Ave., Minneapolis, Minn. (Jr. M. Apr. '50)

Yates, H. B., Supt., Water Dept., Water Works, Princeton, Ky. (Apr. '50)

REINSTATEMENTS

Cardwell, Edward C., Repr., The Dorr Co., 4917 N. Karlov Ave., Chicago 30, Ill. (July '41) *M*

Culpeper, Town of, R. W. Huffman, Town Mgr., Culpeper, Va. (Corp. M. Oct. '44)

Culter, L. W., Cons. Engr., Box 552, Miami 38, Fla. (Apr. '34)

Gullo, Stephen J., Product Control, Pepsi-Cola Co., 3 W. 57th St., New York 19, N.Y. (Jan. '42)

Huffman, R. W., *see* Culpeper, Town of

Hughey, George E., Jr., San. Engr. in Charge of Plants, Water Dept., Statesville, N.C. (Oct. '41) *MP*

Wardle, James McClure, Supt., Dept. of Public Works, City Hall, Hudson, N.Y. (Jan. '47) *MPR*

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(Continued from page 36)

LOSSES

Deaths

Blumberg, Oscar C., Assoc. San. Engr., Bureau of San. Eng., State Dept. of Public Health, 2180 Milvia St., Berkeley 4, Calif. (Feb. '30) *P*

Dundas, Ray W., Sales Engr., Edward R. Bacon Co., 17th & Folsom, San Francisco, Calif. (Oct. '49)

Egan, Frank J., Vice-Pres., James B. Clow & Sons, Box 6600A, Chicago 80, Ill. (Apr. '44)

Kauffman, James B., Assoc. Engr., Bureau of Water Supply, 704 Charing Cross Rd., Baltimore 29, Md. (July '42)

Rooney, John T., Mgr., Monongahela Valley Water Co., Market St., Elizabeth, Pa. (Oct. '43) *M*

Sanborn, James F., Waquoit, Mass. (Aug. '21)

Tischer, H. G., Mgr., Water, Gas & Sewage Disposal Dept., 414–16 W. 1st St., Duluth 2, Minn. (July '41) *MP*

CHANGES IN ADDRESS

Changes received between April 5 and May 5, 1950

Aldrich, Ellwood H., American Water Works Co., Inc., 121 S. Broad St., Philadelphia 7, Pa. (July '35) *MR*

Applebaum, Samuel B., Meadowbrook, Pa. (Apr. '16) *P*

Budrick, Robert J., San. Engr., Dept. of Public Works, Box 387, Boonton, N.J. (July '49)

Dohn, Charles W., Civ. Engr., Franklin Hudson, Cons. Engr., 18 W. Jersey St., Elizabeth, N.J. (Jan. '49)

Freeman, Philip D., Cons. Engr., 4901 Cooley Ave., Box 6095 Milan Station, Norfolk 8, Va. (Oct. '44)

Goodrich, Ralph D., Chief Engr., Upper Colorado River Com., City Administration Bldg., Grand Junction, Colo. (Oct. '48)

Hanks, Fred W., Co., 646 E. 106th St., Cleveland 8, Ohio (Assoc. M. June '26)

Hubbard, Edward, 1460 W. 28th St., Los Angeles 7, Calif. (Jan. '33) *M*

Larson, Linné C., 3425 Amesbury Rd., Los Angeles 27, Calif. (Apr. '36) *MPR*

Lowe, Robert P., 520 N. 7th St., Las Vegas, Nev. (Jan. '43)

Moore, G. W., 32 Park Ave., Latham, N.Y. (Apr. '37) *P*

Nelson, Fred B., R.F.D. 1, Katonah, N.Y. (July '07) *M*

Peterson, C. J., Town Mgr., 745 S. Grant, Wray, Colo. (July '46) *PR*

Randle, Harold, Engr., Calgary Power Co., Ltd., 140—1st Ave., W., Calgary, Alta. (Apr. '42) *MPR*

Riedel, Carl Martin, Cons. Engr., Soil Solidification, 7658 S. Laflin St., Chicago 20, Ill. (June '33) *Goodell Prize '46. R*

Robinson, T. C., Mgr., San. Dist., Great Falls, S.C. (July '38)

Shapiro, Maurice A., 1257 King Drive, El Cerrito, Calif. (Oct. '43)

Vilaret, Manuel R., Calle 29, No. 208, Vedado, Havana, Cuba (July '45)

Wagner, Richard F., City Hall, Norfolk, Va. (Nov. '19)

Watt, Dan M., Constr. Engr., Dist. of Columbia Water Supply, 5910 Dalecarlia Pl., N.W., Washington 16, D.C. (Jan. '49)

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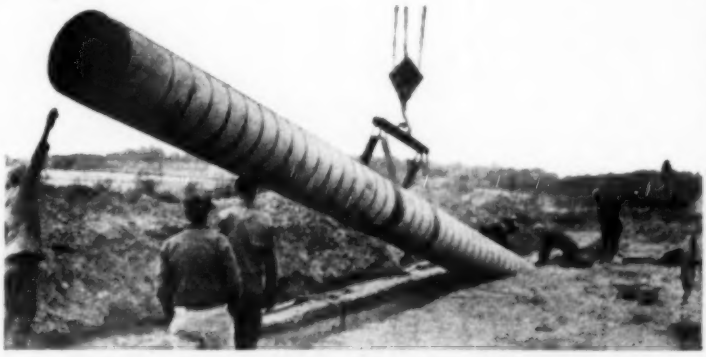

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Key: In the reference to the publication in which the abstracted article appears, **39**:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is paged by the issue, **39**:5:1 (May '47) indicates volume 39, number 5, page 1, issued dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *B.H.—Bulletin of Hygiene (Great Britain); C.A.—Chemical Abstracts; I.M.—Institute of Metals (Great Britain); P.H.E.A.—Public Health Engineering Abstracts; S.I.W.—Sewage and Industrial Wastes; W.P.R.—Water Pollution Research (Great Britain).*

POLLUTION CONTROL

Interim Report to the International Joint Commission. Board of Technical Advisers on Pollution of International Boundary Waters. 28 pp. (Mar. '49). Investigation of poln. by sewage and indus. wastes in international boundary waters of St. Clair R., Lake St. Clair and Detroit R.; also, St. Mary's R. Large number of samples collected in '46 and '47, with investigation of 47 major indus. plants in U.S. and 20 in Canada, poln. by navigation, and water qual. Present study covers practically same area as in '13. Waters extensively used for variety of purposes. Since '13, indus. wastes have become major problem. About 90% of pop. affected lives in U.S. Partial treatment for 2,260,000 pop. (out of 2,385,000) in U.S., and complete treatment for 7,000 (out of 204,600) in Canada. Increase in sewage poln. has augmented potential hazard to domestic water supply, and damages recreational uses and fish and wild life. In U.S., some corrective measures under way. In Canada, little done. Poln. by navigation has become major hazard. Indus. wastes have increased in variety and vol., amtg., in U.S., to 1,204 mgd.; in Canada, to 374 mgd. Among more signif. wastes are phenol and phenolic equivs., as 0.1 ppm. of phenol imparts taste and odor (0.002 ppm. in chlorinated water causes objectionable taste and odor). Phenol tends to taint fish flesh and kill fish. Cyanides very toxic, concns. of 0.1–0.3 ppm. reported to kill fish. In U.S., 3,470 lb./day enters waters, as against 5 lb./day in Canada. Ammonium compds. cause fluctuations in chlorine demand. Toxicity to fish regulated by pH concn. and death may occur in 10 days or less with 2.5 ppm. of ammonia, at pH 7.4–8.0. In St. Clair and Detroit Rivers and in Lake St. Clair, U.S. produces 12,190 lb./day; Canada, 560 lb./day. In St. Mary's R., Canada produces 48,020 lb./day, U.S. none. Oils and other sol. materials also found—in U.S., 16,280 gpd.; in Canada, 4,010 gpd. B.O.D. became important in River Rouge and River Thames, where anaerobic nuisance occurred. For St. Clair and Detroit Rivers and Lake St. Clair, B.O.D. of indus. wastes found to be 306,600 lb./day in U.S. and 114,600 lb./day in Canada. In St. Mary's R., B.O.D. in U.S. 7,800 lb./day; in Canada, 223,500 lb./day. Suspended solids discharged by industry totaled 1,707,400 lb./day in U.S., and 668,300 lb./day in Canada. In '13, major source of poln. domestic sewage. In '48, oxygen-depleting poln., when adequately diffused, not major problem. *Esch. coli* results differ widely with location. Indus. wastes chief source of chem. poln., but not evenly distributed. Substantial number of samples show phenol. concns. in excess of 0.01 ppm., with occasional samples as high as 0.40 ppm. Oil present at many bathing beaches. Complaints have arisen from tastes and odors due to indus. wastes. Float tests indicate that in certain areas poln. travels from either side of boundary to other. Hearings of commission (12 days) developed that poln. from both indus.

(*Continued on page 42*)

Horton Welded Elevated Tank

The town of South Salt Lake, Utah, installed the 300,000-gal. welded elevated tank shown above to provide gravity water supply in its new water system. Since the installation of the elevated tank, operating costs in the system have been reduced more than 50 per cent. Write our nearest office for estimating figures when planning waterworks improvements.

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(Continued from page 40)

wastes and domestic sewage in '45 created complaints in both countries, affected munic. water supplies, and injured fish, wild fowl and aquatic life. Industries working to treat their wastes. Municipalities studying extension of facilities but relatively inactive in constr. because of financial problems. Poln. has interfered with recreational use of waters. Regional planning indicated as helpful. Estd. costs of remedial measures: for U.S., municipal $68,000,000, industrial $13,000,000; for Canada, municipal $14,000,000, industrial $3,000,000. Advisory board recommended that commission maint. contact with poln. control problem, formulate program and work for cooperation of all agencies concerned.—*Ed.*

Interim Recommendations on the Disposal of Radioactive Waste by Non-AEC Users. Circular B-6, Isotopes Div., U.S. Atomic Energy Com., Oak Ridge, Tenn.; Nucleonics **5**:*2*:*22* ('49). National Committee on Radiation Protection has appointed subcommittee to study broad problem of radioactive waste and formulate recommendations for authoritative use. Expected that this committee will require several years to present recommendations. In meantime group of 24 radiological scientists representing industry, medical science, university research and AEC met in Washington to consider interim recommendations for disposal of radioactive wastes by noncommission users. Detailed recommendations adopted for disposal of radioiodine, radiophosphorous and radiocarbon by one or more of following methods: diln. with water, air or other media; diln. of radioisotope with stable isotope before final disposal; diln. with media such as concrete, and burial; and confinement after reducing bulk liq. waste by evapn., pptn., ion exchange or incineration. Concentrated radioactive materials of long life would be confined more or less indefinitely and materials of short half-life would be stored until activity decays to value which would allow disposal by diln. and dispersion.—*S.I.W.*

Water Pollution Abatement Manual for Insoluble and Undissolved Substances. Manual W-*2*, Manufacturing Chemists' Assn., Washington, D.C., 12 pp. (Aug. '49). Manual prepd. by Water Pollution Abatement Committee. Topics covered in 7 sections of manual: effect on receiving waters, permissible concns., removal of solids from wastes, sludge digestion, sludge dewatering, sludge disposal and equipment sources. Section on solids removal most extensive, being subdivided into brief discussions on screening, disposal of screenings, sedimentation and clarification, lagoons, detritus tanks, sedimentation tanks, flotation and filtering.—*S.I.W.*

DISINFECTION

Experimental Investigation of Factors Hindering Decontamination of Water by Means of Chlorine. S. V. Moiseev. Gigiena i Sanit. (U.S.S.R.), **10**:*22* ('49). Following factors may decrease effectiveness of chlorination of water supply: humic substances of natural waters which have high surface activity, self-coagulation (at low pH), or coagulation by electrolytes or colloids of waste liquors from chem. plants, and coagulation of colloids of such waste liquors by components of natural drinking waters. Products of protein hydrolysis and amino acids not appreciably effective unless present in over 2-ppm. concn.—*C.A.*

The Use of Iodine for Disinfection of Drinking Water in the Regions of Endemic Goiter. V. B. Khazan.

(Continued on page 44)

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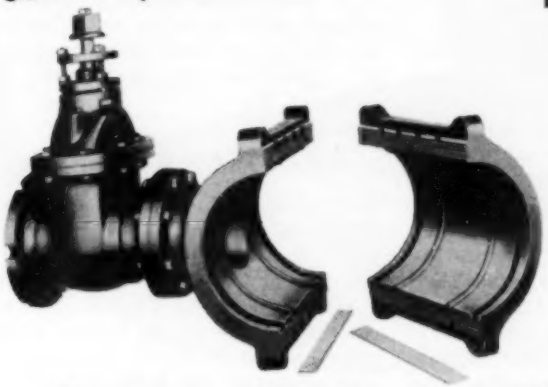

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(Continued from page 42)

Gigiena i Sanit. (U.S.S.R.), **13**:9:6 ('48). Use of 0.02% soln. of I in water comparable in its disinfectant effects on *Esch. coli* and pathogenic intestinal microflora to effects of chlorination. Generally, *Esch. coli* titer of 100 can be reached after 2-hr. contact with 2–5-ppm. concn. of I. This concn. also insures adequate I supply for pop., if daily intake 2–3 l. Combined use of Cl and I (total concn. as above) equally effective bactericidally, in addn. serves to reduce final I concn. in water, which is of importance in prevention of too high intake of I.—*C.A.*

Disinfection of Water. I. Free Iodine. KAREL SYMON. Scripta Med. Facultat. Med. Univ. Masaryk. et Palack. (Czech.), **23**:1:1 ('49). Lethal effect of I on water microbes tested with Lugol or aq. solns. As disinfectant, I equals Br, and is 10 and 80,000 times more active than Cl and PhOH, respectively. Its effect increases with falling pH; decreases with increasing hardness of water; optimum temp. 20–30°. Org. matter binds some I and inactivates it; to det. required amt. for disinfection, I no. of water should be detd. before actual test run on sample.—*C.A.*

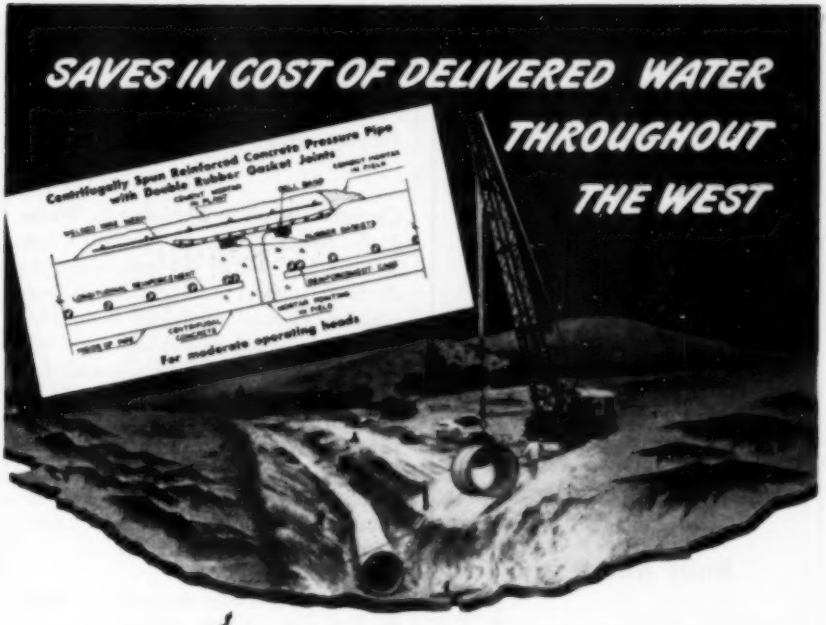
The Performance of High-Pressure and Very-High-Pressure Mercury Vapor Lamps for the Sterilization of Drinking Water. P. OESTERLE & H. HELD. Deut. Gesundheitsw. (Ger.), **2**:608 ('47). Most effective region of spectrum for destroying microorganisms by ultraviolet radiation 225–75 mμ. Lamps used were 120-w. Hg Q 500 lamp operating at 4 atm. and 500-w. HBO 500 lamp operating at 35 atm. Berlin city water (dechlorinated with $Na_2S_2O_3$) and water from river Spree inoculated with *Esch. coli* and *Micrococcus pyogenes aureus* so as to give heavily contamd. samples. Exposure to HBO 500 lamp destroyed almost all bacteria present. Exposure to Hg Q 500 lamp destroyed all bacteria present, especially when samples filtered to clarify and decolorize them before exposure. HBO 500 lamp, however, not satisfactory for this work because of large amt. of heat developed, which made cooling necessary in order to keep temp. from exceeding 37°. Bacteriol. results reported in tables.—*C.A.*

CHEMICAL ANALYSIS

Method for the Determination of Chlorides. W. LEITUE. Mikrochemie ver. Mikrochim. Acta. (Austria) **33**: 171 ('47). Method for oxidimetric microtitration of 0.001–0.50 mg. of chloride described. To sample to be tested are added 0.002 *N* soln. of potassium chromate and 0.002 *N* soln. of silver nitrate in known excess of amt. required to produce red ppt.; soln. shaken vigorously with pptd. calcium carbonate, filtered, treated with mixt. contg. equal quants. of sulfuric acid, 80% phosphoric acid, and water, and titrated with 0.004 *N* std. soln. of ferrous sulfate, using 2% soln. of diphenylamine sulfonic acid as indicator. For detg. 0.02–2 mg. of chloride, 0.01 *N* solns. of potassium chromate and silver nitrate and 0.002 *N* soln. of ferrous sulfate used. Corrections made to allow for loss during filtration and method for calcg. results given.—*W.P.R.*

Determination of Fluorine in Potable Waters. REINALDO SPITZNER. Arquiv. Biol. e Tecnol., Inst. Biol. e Pesquisas Tecnol. (Brazil), **2**:233 ('47). Directions given for detn. of F in water, rocks and teeth by Zralizarin colorimetric method. Water supplies of 55 municipalities in state of São Paulo deficient in F (0.10–0.60 ppm.) with 1 exception (1.2 ppm.).

(Continued on page 46)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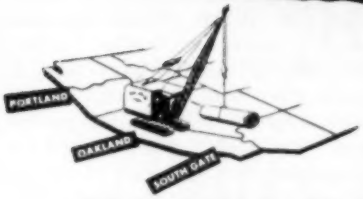

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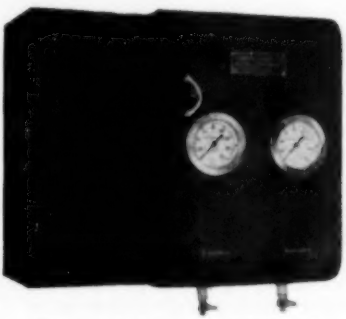

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(*Continued from page 44*)

Daily administration of 5 mg./kg. of body wt. produced fluorosis in rats, teeth of which then contained 0.612 mg./kg. of F (normal 0.012 mg.).—*C.A.*

Determination of Fluorine in Water. J. A. STEVENS. J. S. African Chem. Inst., 1:1:1 ('48). Th substituted for Zr in titrimetric modification of Scott-Sanchis method for estg. F in H_2O. Sample buffered to pH 2.8 with soln. contg. 9.45 g. ClH_2CCO_2H and 2 g. NaOH in 100 ml. H_2O or to pH 3.3 with 0.4*N* CH_3COOH soln. Sample titrated with soln. contg. 1.52 g. $Th(NO_3)_4$/l. to pink color and compared with stds. Correction for SO_4 content made by adding std. Na_2SO_4 soln. to comparison stds.—*C.A.*

Photometric Determination of Magnesium in Water With Brilliant Yellow. MICHAEL TARAS. Anal. Chem., 20:1156 ('48). $Mg(OH)_2$ in strongly alk. soln. converts normal orange color of brilliant yellow dye to red. Positive effect of Al and Ca compensated for by raising concn. of these ions to level where their influence predictable and const. Starch and Colloresin permissible stabilizing agents. High concns. of Cl_2 must be removed. Dye has been applied successfully to anal. of typical natural waters, conventionally treated with filter alum or lime softened.—*C.A.*

Microdetermination of Nitrates. W. LEITHE. Mikrochemie ver. Mikrochim. Acta. (Austria) 33:149 ('47). Chimie & Indus. (Fr.), 60:455 ('48). In method by which small amts. of nitrate can be estd., 5 ml. of *N*/500 ferrous sulfate contg. 1.4 g. of sulfuric acid per l. mixed with 5 ml. of aqueous soln. of nitrate to be tested; 1 g. of sodium chloride then added. Soln. boiled for 3 min., 0.3–0.5 g. of potassium bicarbonate added, and after cooling, 1 g.

(*Continued on page 48*)

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(Continued from page 46)

of sodium hydrogen phosphate added. Soln. then titrated against $N/1000$ potassium dichromate using $\frac{1}{400}$ M ferroin as indicator. 1 ml. of $N/1000$ potassium dichromate equiv. to 0.0207 mg. of nitrate.—*W.P.R.*

New Method for the Colorimetric Determination of Nitrites and Nitrates in Potable Water. JUAN A. SANCHEZ. Rev. Asoc. Bioquim. Argentina (Arg.), **16**:64:3 ('49). Detn. of nitrites based on formation of pink resorufin from resorcinol and nitrites. Add to 1-ml. sample of water 2 ml. distd. water, 0.5 ml. 1% resorcinol, acidified by 5 drops concd. H_2SO_4, and 10 drops concd. H_2SO_4; shake, heat for 30 min. on boiling-water bath and compare color with that of simultaneously prepd. stds. contg. 0.01–0.03 mg. nitrite. Chlorides, sulfates, carbonates and small amts. of nitrates do not interfere. NOCl gives same reaction; nitrate can be detected by same procedure if it is transformed into NOCl by addn. of 10 more drops of concd. H_2SO_4 and 10 drops HCl to mixt. before heating. Color stable for several days.—*C.A.*

Determination of Dissolved Oxygen in Degassed Water. M. DELASSUS, R. DEVAUX & P. MONTIGNY. Chaleur & Ind. (Fr.), **30**:159 ('49). Authors present critical review of precision methods used for detn. of traces of free O_2 in water with particular reference to boiler feedwaters for high-pressure steam systems where max. allowable O_2 content of order of 0.072 ppm. Two procedures are modifications of Winkler method which is based on oxidation of causticized soln. of $MnCl_2$ and subsequent liberation of I_2 after addn. of excessive KI and acidification with HCl. Sensitivity of this method, in which direct titration with $0.1N$ $Na_2S_2O_3$ used, limited because 500-ml. sample of H_2O with max. permissible O_2 content of 0.072 ppm. would consume only 0.05 ml. of $0.1N$ $Na_2S_2O_3$. Potentiometric method developed by Perley reviewed in comparison with colorimetric method which is said to be sensitive in O_2 range of 0–0.5 ppm. Latter method based on yellow color developed between *o*-tolidine and Cl_2 after latter liberated with HCl from MnO_2; H_2O obtained by oxidation of Winkler reagent (alk. $MnCl_2$). Concluded that both methods yield satisfactory results even with O_2 concns. of order of 0.01 ppm. However, relative error with potentiometric method increases toward very low concns. while negligible in range above 0.08 ppm. Relative error with colorimetric method (about 2%) remains const. even at values below 0.003 ppm. Thus latter method preferably employed for low concn. ranges. Exact details of operating procedures and app. construction given for both methods.—*C.A.*

Reform of the Accepted Unit of Hardness of Water. M. G. TIKHMENEV. J. Applied Chem. (U.S.S.R.), **21**:1306 ('48). Proposed unit, called "Russian degree of hardness," corresponds to content of 1 g. of Ca^{++} ions (or equiv. amts. of other ions producing hardness) in 1 l. of water. Thus, one "Russian degree" equiv. to $\frac{5}{7}$ German degrees, defined by content of 1 g. CaO/l.—*C.A.*

Principles and Application of Electrolytic Conductivity. ROBERT ROSENTHAL. Wtr. & Sew. (Can.) **87**:4:23 (Apr. '49). Specific conductance of soln. is reciprocal of resistance in ohms of 1 ml., unit being reciprocal ohm or mho, or, for very dil. solns., micromho. Conductance depends upon total no. and kinds of ions and upon temp., and in very dil. solns. almost exactly proportional to electrolyte content. Detn. made by measuring resist-

(Continued on page 50)

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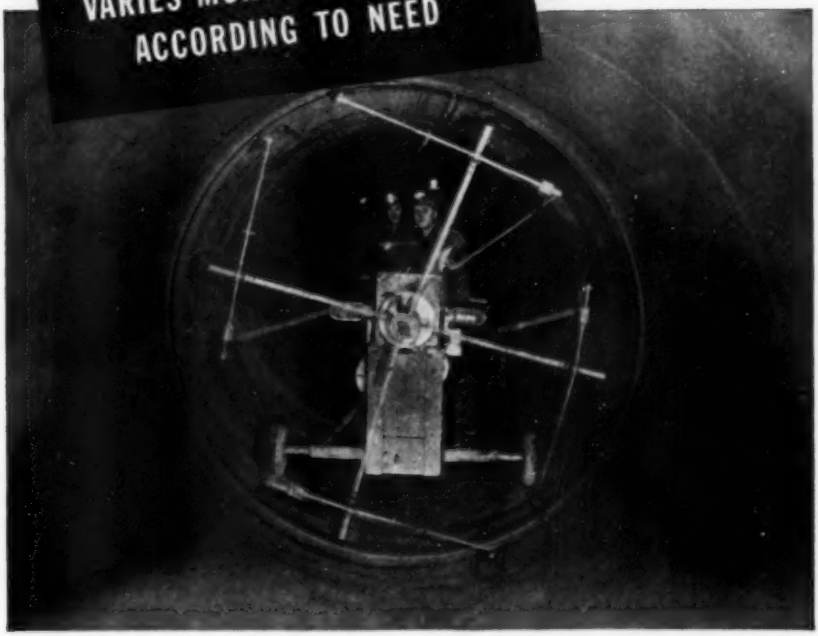

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(*Continued from page 48*)

ance with Wheatstone bridge in 1 of several types of cells which basically consist of 2 metal plates, or electrodes, firmly spaced within insulated chamber which isolates portion of liq. under test. App. available for continuous recording and for actuating control or signaling devices. Concns. as low as 0.1 ppm. measured accurately. Applications include detection of contamn. of distd. water, returned condensate and cooling waters, and other control procedures depending upon fluctuations in soln. concn.—*R. E. Thompson.*

FAR EASTERN SUPPLIES

Australia's Snowy River Scheme. ANON. Wtr. & Wtr. Eng. (Gt. Br.), **52**:597 (Dec. '49). Snowy R., with tributaries, drains 700 sq.mi. of Australian Alps, most of which covered with snow from May to Nov. Snowy R. rises near foot of Mt. Kocinsko in New South Wales and enters ocean near Orbost in Victoria. New South Wales proposed to divert water of Snowy through mountains to Murrumbidgee R., whereas Victoria wanted to turn it into Murray R. Committee of these 2 governments with Commonwealth government produced more comprehensive scheme which includes best points of conflicting plans and adds development of upper reaches of Snowy, Murrumbidgee and Murray for power production on large scale before water diverted for irrigation. Scheme gigantic, estd. to cost over £200,000,000, with constr. period of 25–30 yr. Whole scheme bound up with utilization of 2 dam sites, where possible to construct dams with holding capac. near 1,000,000 acre-ft. Final scheme threefold in character: [1] Tumut R. development, by diversion to it of (a) slightly over ¼ of Snowy headwaters (235,000 acre-ft. annually) from Eucumbene R. (tributary of Snowy), (b) upper Murrumbidgee waters and (c) about 330,000 acre-ft. annually from Tooma R. (tributary of Murray); [2] to compensate for diversion of water from Tooma to Tumut R. (tributary of Murrumbidgee), 330,000 acre-ft. annually will be diverted from Snowy to Murray; [3] harnessing upper waters of Murray above existing Hume Res. by constr. of large dam on site yet to be selected. 16 power stations to be built under scheme will be located in solid rock, safe from hostile bombing. Immense amt. of earth-moving equip. will be required. Postwar reconstruction agency empowered to lodge orders for £1,000,000 within sterling block. However, to carry out plan expeditiously, certain amt. of special equip. will have to be secured in America with hard-earned dollars.—*H. E. Babbitt.*

100-Mile Pipeline to Australia's Rocket Range. ANON. Wtr. & Wtr. Eng. (Gt. Br.), **52**:456 (Sept. '49). Morgan-Whyalla pipeline winds 223 mi. across country. Water carried above ground in steel, concrete-lined pipes, supported on concrete blocks. Water pumped from Murray R., passes through 4 pumping stations before it reaches storage reservoir at Hanson. Pipeline branches in 2 directions—south to Whyalla and northwest to Woomera. Western Australian pipeline made possible opening up of Australia's richest gold-producing region. In its 300-mi. journey water lifted 1000′ by 8 pumping stations.—*H. E. Babbitt.*

The Removal of Organic Materials From Surface Water, Particularly From Swamp Water, in Netherlands India. N. D. R. SCHAAFSMA. Delft (Neth.), 124 pp. ('47). Complex organic materials present result in undesirable properties of water. Chemical methods of determining type

(*Continued on page 52*)

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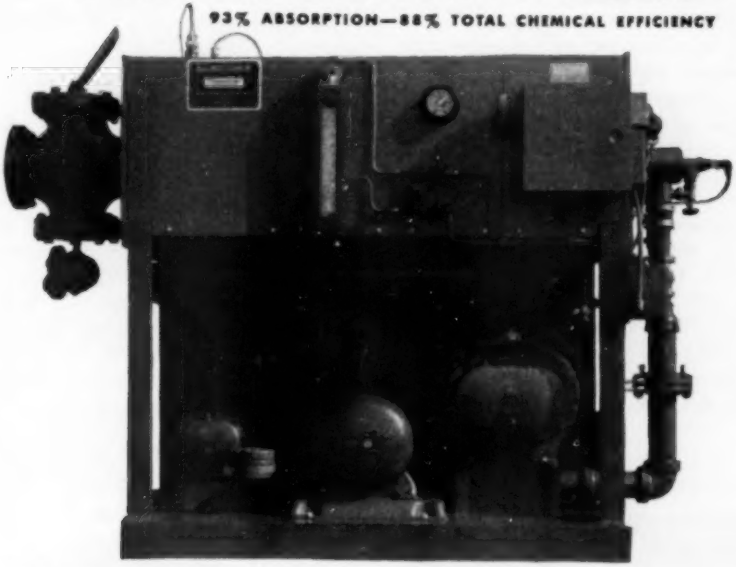

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PROQUIP

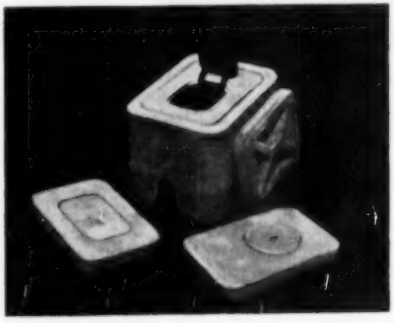
(Continued from page 50)

of compounds poor. In East Indian waters, organic materials vary greatly, but content usually low. Destruction of organic matter with $KMnO_4$ aids coagulation. Sometimes chloramine added after coagulation and filtration. Properties of swamp water determined by character of soluble humic substances, which appear to be negatively charged colloidal particles of different sizes. Monovalent acids and alkalis not suitable for coagulation; of divalent, only Ca ion has value but creates difficulties; trivalent best. Coagulation with $Al_2(SO_4)_3$ and Na_2CO_3 results in precipitate of Al and SO_4, CO_3 and OH groups; with lower pH values, OH group replaced by SO_4 and CO_3 radicals. Results with $Al_2(SO_4)_3$ and Na_2CO_3 poor. Coagulation with $FeCl_3$ and CaO added simultaneously never produced iron-free water. Double coagulation, using $FeCl_3$ and lime successively, produced good results. Remaining humic substances could be oxidized with Cl and filtered through activated carbon. Organic matter decreased in direct proportion to Cl.—*W. Rudolfs.*

ANNUAL REPORTS

Pasadena (Calif.) Water Dept. Annual Report (1948–49). Water production 1,043,793,200 cu.ft., increase of 387,400; 7.6% from gravity sources (streams in Eaton, Millard and Arroyo Seco Canyons), 25.6 from underground basins, 66.8 softened Colorado R. water from Metropolitan Water Dist. of Southern California. Metered services 34,611 (gain of 891), 83% within city. Estd. pop. served 135,000, 112,000 within city. Consumption

(Continued on page 54)



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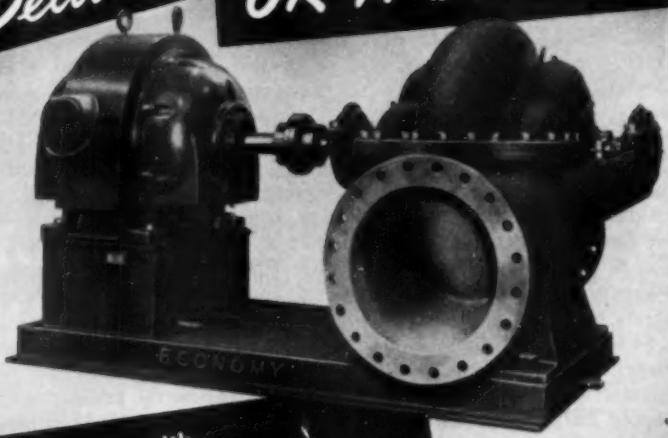

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DIVISION OF HAMILTON THOMAS CORP. HAMILTON, OHIO

(Continued from page 52)

19.59 mgd., per capita 146.8 gpd. Rainfall 12.25", 60% of normal. During past 5 yr. of low pptn., water level in Casitas Well receded 28', in Garfield Well 1'. Water sales $1,559,956.94, increase of 11.7%, total operating revenue $1,716,213.75, total revenue $1,860,070.69, operating expense including depreciation $1,528,855.26, net gain from operation $187,358.49, 2.59% of capital invested. Eighth yr. that total assessed against city for district purposes paid from water funds; 75% so paid since district organized in '29. Contribution to general fund of city $82,705.87. Book value plant and equip. (depreciated) $5,698,682.91, current assets $1,521,779.86, bonds outstanding $4,404,000 (all San Gabriel bonds, no general water dept. bonds). Cost of water, cents per 100 cu.ft.: gravity supply 2.57, ground water supply and pumping 0.76, purif. 0.37 (total production expense 3.70), transmission and distr. 0.84, commercial 0.64, general 2.01, Metropolitan Water Dist. obligation 4.04, contribution to city fund 0.72 (total operation and maint. 11.95), depreciation 1.30, total 13.25. Projected new 50-mil.gal. Hastings Res. will increase storage capac. to 116 mil.gal., 3-day supply under max. use. Mi. of mains 397 (85% cast iron), gate valves 4423, hydrants 2021, meters 34,611, services 39,303, pumping stations 26 (total capac. 60,011 gpm.). Cost of pumping deep wells per 1000 cu.ft. per 100' head 4.77¢, booster pumping 4.44¢. Domestic rates: 25¢ per 100 cu.ft. for min. per mo., depending on meter size; 9–14¢ above min.; 20–25% higher outside city; irrigation 6¢ per 100 cu.ft., 7¢ outside city, plus $0.45–$2.35 plus serv-

(Continued on page 56)

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Clow Cast Iron Pipe is centrifugally cast —in sizes from 3 to 24", in 18' lengths, and for working water pressures to 250 lbs. Meets Federal Specifications WW-P-421 for Bell and Spigot Cast Iron Pipe for Water. Can be easily cut in the field if needed, and drilling and tapping it for services results in superior threads and perfect connections.

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Iowa Valve Co., Oskaloosa, Iowa

(*Continued from page 54*)

ice charge inside city and $0.50–$2.60 outside. Rates increased Jan. '48. Chem. anal. of various supplies given. Avg. weighted hardness 137 ppm., Colorado R. supply 136. Automobile operation and maint. 7.51¢ per mi.—*R. E. Thompson.*

Hartford (Conn.) Water Bureau. Metropolitan District Commission. Annual Report (1948). District, incorporated in '29, includes Hartford, Bloomfield, Newington, Wethersfield, Windsor, East Hartford and Rocky Hill. Principal source of supply Nepaug Res., el. 482.5, capac. 9544 mil. gal., safe yield 21 mgd., delivered to West Hartford works through cast-iron and concrete pipelines 36–48″ diam. and tunnel through Talcott Mt. New Barkhamstead 30-bil.gal. storage reservoir on East Branch of Farmington R. in process of filling—drainage area 53.8 sq.mi., el. 530′, surface area 2500 acres, estd. safe yield 46 mgd., piped to Nepaug Res., 8 mi. distant. Water filtered at West Hartford slow sand plant—14 filters, total area 7.5 acres—flowing into 2 clear-water reservoirs (capac. 15 mil.gal.), thence to distr. system. Chlorination, begun as war emergency measure, now permanent part of treatment. In addn., water obtained from 2 Glastonbury reservoirs, total capac. 13 mil.gal., supply source of East Hartford when latter joined district. This water chlorinated only. Estd. pop. served 317,000. Avg. consumption 32.04 mgd., increase of 1.6%, filtered 30.67 and chlorinated unfiltered 1.38. Gross revenue $1,737,-071.69, 2.6% decrease, of which $1,-698,308.65 from water sales, 2.9% decrease. Operating expense, including depreciation and taxes, $1,215,295.53, 9.7% increase. Deficit $112,235.37. Anal. of costs: supply 8.9, purif. 5.4, taxes 2.3, transmission and distr. 13.4, acctg. 4.6, administration 20.3, depreciation 15.1, fixed charges 36.4, deficit 6.4%. Book value of plant $34,162,-777.38, depreciation reserve $6,198,-043.81. Long-term debt reduced to $8,949,000 by retirement of $544,000 bonds. Four addnl. 0.5-acre filters projected to increase capac. from 35 to 45 mgd. Avg. rate of filtration 4.18 mgd., max. 6.8 for limited periods. Avg. color reduced from 17 to 8.5 ppm., bacteria from 493 to 3.5 (after chlorination). Cost of filtration and chlorination $8.10 per mil.gal., of filtration only $7.12. Mi. of mains 661, services 42,607, hydrants 4289, meters 41,307, standpipes 3. Meter operation and maint. cost $1.03 per meter in service, $4.79 per meter tested ($3.66 for labor). Automobile operating cost 8.2¢ per mi. 22 rainfall and 6 stream flow stations. Rainfall 45–48″. Meters read largely quarterly and billed semiannually. Penalty for overdue accts. 5%, another 1% being added each mo. 576 shutoff notices sent (1 mo. overdue) during yr. and service discontinued once. Net worth $15,-096,369.05, total assets $35,950,397.30. Avg. qual. water supplied: bact. count (20°C.) 4, (37°C.) 2; 19 of 2430 10-ml. portions contained coliforms; hardness 15 ppm., turbidity 0.5, color 8, total solids 35, pH 6.4.—*R. E. Thompson.*

Kalamazoo (Mich.) Light & Water Utilities. Annual Report (1948). Source of supply natural water basin underlying city. Supply works consist of 10 pumping stations and 30 wells, capac. 19.76 mgd.—6 major stations pumping directly into mains, 3 minor stations furnishing water at low pressure to 1 or more major stations, and 1 booster station. Avg. temp. 54°. Frequent bact. examns. by city health dept. Entirely self-supporting, all income from water charges and equiv. of city, state and federal taxes paid into city treasury. Reservoir, 7-mil.gal. capac., and 0.52-mil.gal. standpipe float

(*Continued on page 58*)

Drury-McNamee & Porter specified TOREX *in color for filters as early as 1937*

DRURY-McNAMEE & PORTER, Consulting Engineers, Ann Arbor, Michigan, specified Torex Enamel Deep Sea Green in 1937 for the submerged concrete filter basins at Highland Park, Michigan. Applied that year, Torex still beautifies the concrete.

What Torex means to the client. A novel idea it was at the time, to paint submerged concrete with a cheerful color. Now most engineers recognize that Torex Enamel brings a sparkle to the water, a new beauty to the plant. Because of the tilelike Torex finish, the plant stays spotlessly clean almost without effort. Deputy Superintendent Vern Hinebrook, pictured above, says: "I'm really proud of my filter plant!"

Why does Torex last so long? Constant submersion in water does not soften the resistant rubber base. Nor do chemicals like soda, alum and chlorine. Torex remains tough and hard. It adheres firmly to the concrete. It never peels, blisters or powders off.

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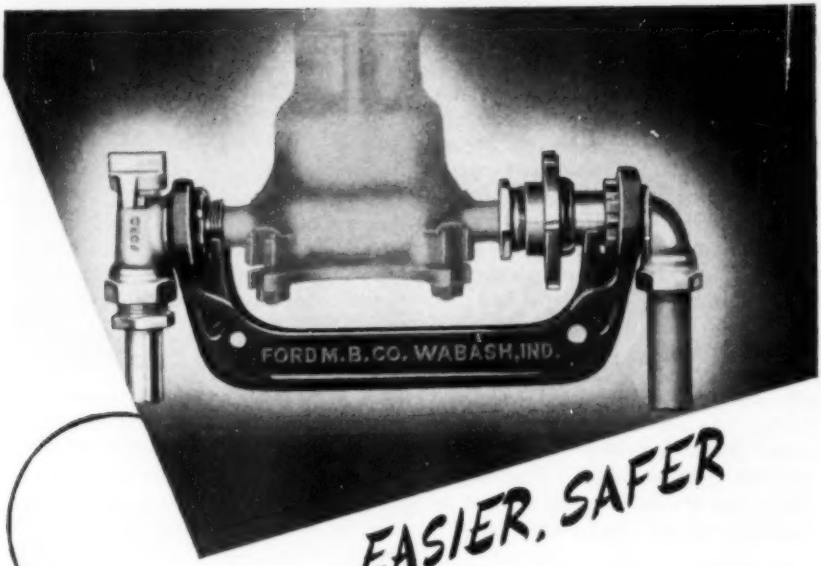
(*Continued from page 56*)

on low-pressure district, and 2 elevated tanks, 0.35- and 0.75-mil.gal. capac., respectively, float on high-pressure district served by booster station. Total customers 15,943, of which 1887 outside city—100% metered. Avg. pumpage 9.71 mgd., max. day 18.4, pop. served 61,450, consumption per capita 158 gpd. Gal. pumped per kwhr. 825.7, cost of power to pump 1000 gal. 1.86¢. New well field being developed—6 wells, 3-mgd. estd. capac. Existing wells being reconditioned—surging and acid treatment increased capac. of one from 600 to 1500 gpm. Mains 183 mi., gate valves 2313, hydrants 1233. Services installed by dept., billed at cost to customer, maintd. by dept. Fixed assets $2,539,901.01, less depreciation reserve $674,851.09, current assets $585,602.55, work in progress $233,134.24, total $2,683,786.71. Surplus $2,200,959.53, increase of $20,049.46. Operating revenue $350,243.73, operating expenses $199,740.33, depreciation $41,245.59, taxes $39,316.20, operating income $69,941.61, net income $57,987.51, equiv. to private company net income of $28,766.31 after state and federal taxes.—*R. E. Thompson.*

St. Paul (Minn.) Board of Water Comrs. Annual Reports (1947–48). As of Dec. 31, '48, total assets $23,568,523.41. During '47 and '48, respectively, operating revenue $1,562,762 and $1,691,694, operating expenses $836,254 and $990,094, debt and interest $464,985 and $460,500, net operating income $261,523 and $241,100, net operating and nonoperating income $373,644 and $355,926. During past 20 yr., 38.5% of all capital outlays paid from operating profits. To meet rising costs, rates increased Feb. 1, '47. Avg. rate for water 10.65¢ per 100 cu.ft. in '46, 12.05¢ in '47, 12.37¢ in '48. Avg. consumption in '47 and '48, respectively, 30.7 and 33.65 mgd., per capita 99.1 and 105.2 gpd. In addn., private wells supplied 16 and 18 mgd., respectively. Water unaccounted for 11.36 and 12.92%, respectively. Study of feasibility of installing surface wash in filters, 12 of which 27 yr. old, indicated more efficient washing and operating results obtainable. In '48, cost of chem. $7.98 per mil.gal., total treatment cost $18.16, increase of 6¢. Avg. hardness reduced 101 ppm. at cost of $8.49 per mil.gal. Main maint., including hydrant and valve repairs, $43.58 per mi. Cost of meter maint. per meter per yr. ranged from 15.26¢ for ¾" to 49.88¢ for 2". In '48, 172 accts. shut off for nonpayment—at end of yr., 2967 delinquent accts., totaling $14,833.66. Approx. 15.3% domestic and 3.7% commercial accts. paid with penalty. Live services 71,081. As of Dec. 31, '48, book value of property $22,125,777, net bonded debt $4,409,782. Cost anal., '47 and '48, respectively, in dollars per mil.gal.: operating revenue 134.27 and 131.84, administration 16.88 and 16.71, production 25.38 and 27.99, distr. 27.01 and 29.97, interest 18.22 and 15.60, sinking fund 9.10 and 8.28, serial-bond requirements 14.18 and 13.51. Cost of chem. treatment advanced materially from '40 to '48: lime treatment 82%, Cl 78%, alum 20%; NH_3 declined 25%. Cost of recarbonation 60¢ per mil.gal. in '48, aeration 20¢. Avg. in '47 and '48, respectively, wash water 1.5 and 1.73%, water used for sludge removal 0.46 and 0.75%, filter runs 92 and 90 hr.; chem. dosages, in ppm.: alum 8.86 and 7.55, Na aluminate 1.68 and 1.21, NH_3 (applied as ammonium sulfate) 0.084 and 0.1, Cl 0.99 and 1.07, lime (CaO) 115.5 and 120. Qual. of effluent: turbidity 0, bacteria (37°, 48 hr.) 5 and 4 per ml., (20°, 48 hr.) 5 and 3, colon index trace and 0, color 5.1 and 4, pH 8.4 and 8.5, residue on evapn. (105° C.) 109 and 100 ppm., F 0.12 and 0.12 (same), Mn 0.02 and

(*Continued on page 60*)



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FOR BETTER WATER SERVICES

FORD

THE FORD METER BOX COMPANY, INC.
Wabash, Indiana

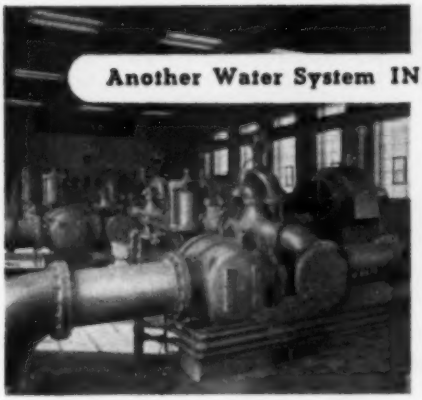
(*Continued from page 58*)

0.03, Fe 0.02 and 0.01, carbonate hardness 62 and 60, noncarbonate hardness 15 and 12. Monthly Langelier index data included for '47. Bact. content of city tap water considerably higher than that of plant effluent, particularly during period June–Oct.—avg. in '47 and 48, respectively, 37° count 55 and 68, 20° count 64 and 119, colon index 0.012 ('48 only). Microscopic examn. made regularly of Mississippi and lake waters and latter treated with $CuSO_4$ when need indicated. In '47 and '48, respectively, estd. pop. supplied 296,500 and 299,000. Accts. metered 99.9%. As of Dec. 31, '48, mi. of mains 661.9, hydrants 5546 (maint. cost per hydrant $3.82), gate valves 5725, no. accts. 71,496, pop. per mi. of main 471.—*R. E. Thompson.*

Erie (N.Y.) Bureau of Water. Annual Report (1948). Supply from L. Erie through 2 intakes, 60″ diam. (36-mgd. capac.) serving Chestnut St. Plant, and 72″ (70-mgd. capac.) serving West Plant. Former consists of 24-mil.gal. settling basin (on peninsula), coagulation basins, 16 2-mgd. rapid sand filters and 0.7-mil.gal. clear well. West Plant, also rapid sand, designed to deliver 16 mgd., and, in emergency, 24. Distr. storage includes 33-mil.gal. open low-service reservoir, 10-mil.gal. covered high-service reservoir, 0.1-mil.gal. elevated tank and 0.3-mil.gal. standpipe. Current assets $1,160,556.30; real estate, buildings and equip. $14,897,922.81; depreciation reserve $4,965,176.52; construction in progress $90,005.99; total fixed assets $10,022,752.28; total assets $11,197,772.72; bonds outstanding $746,000; investment and surplus $10,438,051.10. Water sales $1,095,537.22, miscellaneous receipts $39,358.61, total expenditures $1,090,186.31, including $60,000 principal on indebtedness. Cost per mil.gal. $91.99, of which $68.03 for operation and depreciation, $2.49 interest and taxes, $4.32 debt retirement and $17.14 construction. Free water furnished city $74,692.18. Chem. dosages at Chestnut St. and West filter plants, respectively, alum 0.33 and 0.35 gpg., Cl 3.0 and 5.7 lb./mil.gal., activated C 3.9 and 4.6 lb./mil.gal., ammonia 0.54 lb./mil. gal. (West Plant only); wash water 1.9 and 1.08% of water filtered, respectively; avg. water filtered 22.28 and 15.09 mgd. Avg. anal. of filtered water, both plants: bacteria per ml. 0, coliforms absent from all (1232) samples in 10 ml., turbidity 0, color 10 —. Estd. pop. supplied 148,000, avg. consumption 37.94 mgd., equiv. to 256.3 gal per capita (91.9 after meter registration deducted). Mains 316 mi., hydrants 1733, gate valves 4851, services in use 30,330 (avg. cost of services in '48 $51.71), meters 1532 (5.05% of services), percentage of receipts for metered water 51. Rates (nondomestic) 6–20¢ per 1000 gal. (25% more outside city), apartment houses 4.5–17¢ per 100 cu.ft.—*R. E. Thompson.*

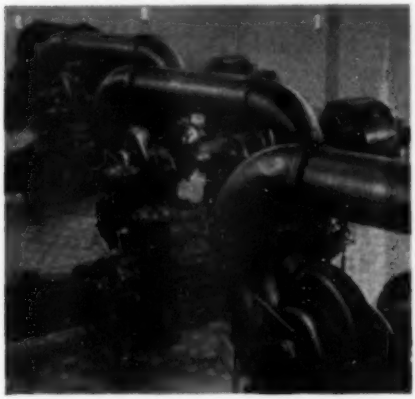
Rand (Un. S. Afr.) Water Board. Annual Report (Year Ending Mar. 31, 1949). Available supply 100 mgd., consumption 86.61, increase of 9.25 over '48. Addnl. supplies under constr. and planned. Rates 6*d.* per 1000 gal., addnl. 5*d.* being charged to nonconstituent authorities, 8*d.* to others and 2*d.* to crushing mines. Avg. cost to all consumers, including fixed charges, 9.74*d.* Working cost 4.07*d.* per 1000 gal., increase of 0.12*d.* over '48. Total revenue £817,294; betterment, revenue and depreciation funds £1,660,407; gross amt. required to meet interest and depreciation £510,902. Loans outstanding £7,083,829, redemption fund £3,144,124, net loans outstanding £3,939,705. Capital expenditures to date, including betterment fund, £13,240,504. Board's rights to Vaal R. water total 225 mgd., of which

(*Continued on page 62*)



Another Water System INSTALLS DE LAVAL PUMPS*

Pumps at the Junction Station Note provision on bed plates for addition of second pump in series to increase head from 150′ to 300′.



Pumps in series at the Whitestone Station. Three of the units have a capacity of 20 mgd and one a capacity of 10 mgd—all against 300′ head.

*78% of all American cities of over 100,000 population use De Laval water works pumps.

De Laval Pumps Deliver Water

80 Miles

The cities of Saginaw and Midland, Michigan, receive water from a point 80 miles away in Lake Huron, the closest source of potable water in adequate quantity,

Two pumping stations, the Whitestone Point Station and the Junction Station, serve this entire supply line. The Whitestone Station is equipped with four De Laval pumping units having a combined capacity of 70 mgd against 300′ head. Each of these units consists of two pumps in series.

The Junction Station is likewise equipped with four De Laval pumping units having a combined capacity of 70 mgd. At present, each of these units consists of a single pump operating against 150′ head, provision having been made for the addition of pumps in series in order to double the total delivered head, if necessary.

Send for Catalog 10-9-JA

DE LAVAL DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES · HELICAL GEARS · CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS · WORM GEAR SPEED REDUCERS · IMO OIL PUMPS

(Continued from page 60)

29 have been sold. Principal supply source Vaal R., impounded in reservoir formed by barrage consisting of 36 sluice gates. Water drawn through 2 intakes and pumped (normal head 120′) into sedimentation system consisting of primary mixing and sedimentation tanks and secondary mixing, carbonation and sedimentation tanks (total mean retention about 17 hr.) and thence through 82 gravity filters. Filtered water chlorinated and stored in underground reservoirs and, except for small percentage, not again exposed directly to atmosphere. Water from underground reservoirs pumped 3 times (total normal head 1725′) to reservoirs of constituent authorities. Total capac. of service reservoirs 114 mil.gal. River supply augmented by series of wells, also chlorinated (0.10 ppm.). Area supplied 4200 sq.mi., with estd. pop. of 2,168,000, of which 1,692,000 within constituent municipalities (643 sq.mi.). Rainfall at barrage 27.6″, daily evapn. 0.04–0.39″. Capac. of pumping and purif. system 90 mgd. Gross supply 93.6 mgd., of which 7% from wells, and net supply, after allowing for water used in purif. process, 89.6 mgd. 2.7% lost by leakage, reservoir overflow and errors in metering. Water supplied 86.6 mgd., max. day 116.6 mil.gal. Water of satisfactory qual. throughout yr.—about 14,000 samples examd. Elec. cond. of raw water 130–440 micromhos/ml. at 20°C., corresponding to 90–390 ppm. electrolyte. Suspended solids 22–305 ppm. Chem. treatment: coagulation with lime (73–120 ppm. $Ca(OH)_2$), recarbonation (30,000–69,000 cu.ft. filtered flue gas, contg. 10% Co_2, per mil. gal.), coagulation with alum (3.6 ppm.), sedimentation, filtration and chloramine disinfection (0.14–0.47 ppm. $(NH_4)_2SO_4$ and 0.34–0.61 ppm. Cl). To inhibit algal growths, 0.35 ppm. $CuSO_4$ added to secondary sedimentation tanks and to open reservoirs during warmer months. Avg. cost of chem. treatment of river water 0.438*d*. per 1000 gal. Raw water agar count (48 hr., 37°C.) 30–3200/ml. Coliforms seldom present in 0.1 ml., frequently in 1 ml., occasionally absent in 10 ml. Treated water bact. count avgd. 6/ml., and all 50-ml. samples examd. for coliforms neg. Independent examn. of samples from Village Depot showed coliforms absent in 100 ml. (none found during past 10 yr.) and bact. count 0–19 with avg. of 4. Avg. residue on evapn. 169, alky. 64, hardness 87 ppm., pH 8.3, cond. 206. Corresponding data for well water 147, 117, 139, 7.9 and 219, respectively. Avg. filter run 111 hr., avg. rate of filtration 68.2 gal./sq.ft./hr. Avg. cost of raising 1000 gal. 100′, 0.0965*d*. Total length of pipelines 6″ diam. and larger 478 mi. All water supplied in bulk and metered. No. of employees 1685. —*R. E. Thompson.*

OTHER ARTICLES NOTED

Recent articles of interest, appearing in American periodicals not abstracted, are listed below.

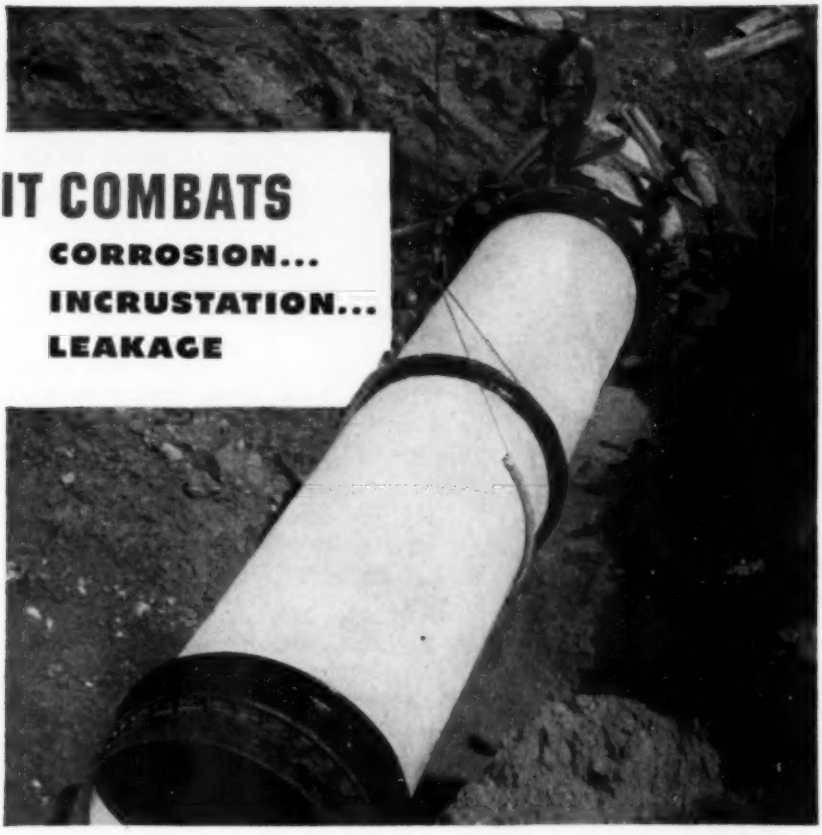
Minimum Requirements for the Control of Industrial Wastes. Washington Pollution Control Com. Sew. & Indus. Wastes, **22**:4:514 (Apr. '50).

Metallizing—A Water Works Maintenance Tool. JOHN E. WAKEFIELD. Am. City, **65**:5:102 (May '50).

Laboratory Tests of Protective Coatings Versus Service Results. W. T. MORAN & G. E. BURNETT. ASTM Bul., p. 73 (Apr. '50).

Flow-Net Construction Simplified by Using Principle of Magnetic Field. H. E. HURST & S. LELIAVSKY BEY. Civ. Eng., **20**:4:48 (Apr. '50).

Effect of Free and Combined Available Residual Chlorine Upon Bacteria in Swimming Pools. ERIC W. MOOD. Am. J. Pub. Health, **40**:4:459 (Apr. '50).



Bethlehem Tar-Enameled Water Pipe is formed from heavy plate steel, carefully welded, then generously coated with a uniform layer of protective tar enamel. As a result, it does an effective job of combating corrosion, incrustation and leakage, thus making it ideal pipe for supply-line service.

Next time you need pipe for water-supply lines, choose Bethlehem Tar-Enameled Water Pipe. It is made in all diameters from 22 in. to 96 in., inclusive. It can also be produced in larger sizes, the maximum diameter being determined by shipping clearances. It comes in a wide range of thicknesses, too, and in any length up to and including 40 ft.

If you would like detailed information about Bethlehem Tar-Enameled Water Pipe, drop a line to us at Bethlehem, Pa.

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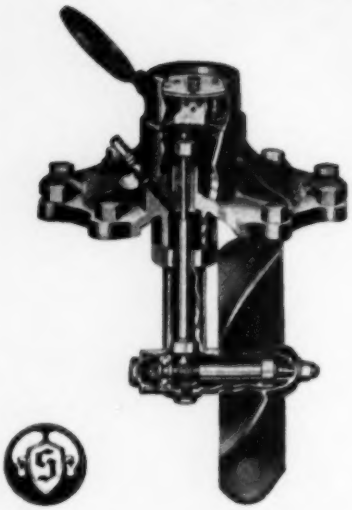
BETHLEHEM *Tar-Enameled* WATER PIPE

SPARLING MAIN-LINE METERS



DIRECT ACTION!

Whether you install a Standard or a Compound Sparling Meter, a large or a small meter, saddle-mounted or tube-mounted, the understandable operation from the flow direct to the register is as shown above. Not only is Accuracy within 2 per cent guaranted throughout the rated range, but the head loss through the meter is negligibly small! And your own men can install the meter.

Bulletin 310 comes upon request

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Service Lines

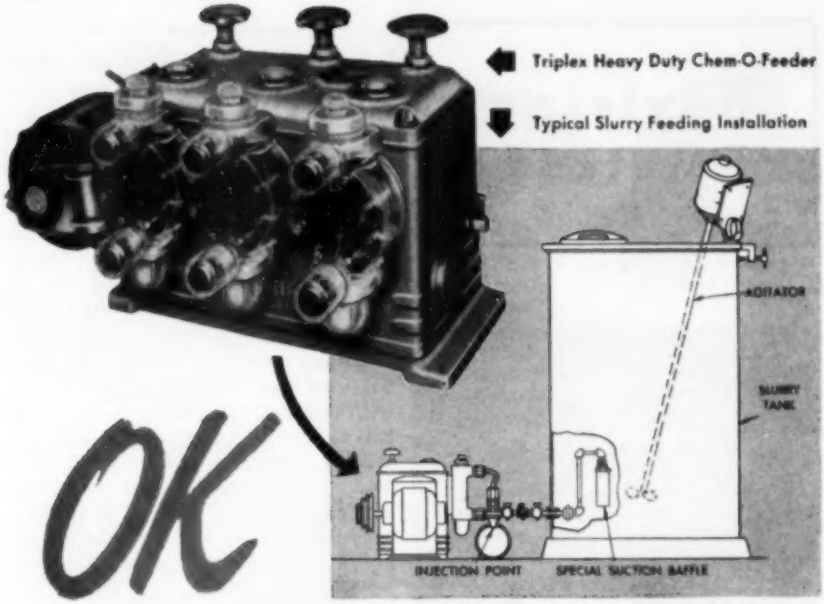
Mueller Co. service clamps are described and illustrated in a booklet which supersedes pages 112-115 of the Mueller Water Works Catalog "H." The clamps feature heavily galvanized malleable iron bodies, with nuts, straps and even strap threads cadmium plated; neoprene gaskets cemented in place; and inner curvature of the straps designed to fit the pipe accurately. Lead ring gaskets are also available upon request. The booklet is obtainable from the company at Decatur, Ill.

The third of a series of annual reports entitled "A Report of Dresser-Coupled Steel Water Lines—1949" has just been published by Dresser Mfg. Div., Bradford, Pa. The eight-page illustrated booklet gives some of the salient data concerning representative pipeline jobs.

The building of custom-made files through the stacking of standardized, mass-produced equipment is the subject of a bulletin on Record-Stack units just published by Remington Rand, 315 Fourth Ave., New York 10, N.Y. The booklet, No. SC 677, includes data on dimensions of the files.

A new booklet entitled "Dollars and Sense of Cathodic Protection for Transmission and Distribution Pipelines" has just been published by Electro Rust-Proofing Corp. (N.J.), Belleville 9, N.J. It includes an outline of the procedure used, a summary of some case histories and factual information about the economics involved.

(Continued on page 66)



For FEEDING SLURRIES *Against Pressure!*

- **LIME SLURRY FOR pH CORRECTION**
- **ACTIVATED CARBON SLURRY FOR TASTE AND ODOR CONTROL**
- **DIATOMACEOUS EARTH SLURRY FOR FILTRATION**
- **CALCIUM CARBONATE SLURRY FOR WATER CONDITIONING**

%Proportioneers% new Heavy Duty Chem-O-Feeder solves a difficult feeding problem — it's ideal for feeding abrasive slurries against pressure — positively, accurately — without wearing out pump parts. For handling slurries the Chem-O-Feeder has semi-knife edge check valves of stainless steel or silver, with a diaphragm of whipcord-reinforced soft rubber.

The feeding rate can be adjusted with extreme accuracy by merely turning a knob, without stopping the Chem-O-Feeder. A magnifying register glass shows exact reading of stroke length in increments of .001". The plastic See-Thru reagent heads, convenient oil fill, and automatic lubrication reduce maintenance to a minimum. Chem-O-Feeders are available in Simplex, Duplex and Triplex Models to feed up to 8 g.p.h. per unit at pressures to 125 psi. Can be furnished with one or more slurry feeding heads, with other heads feeding different water treating chemicals. Write for information.

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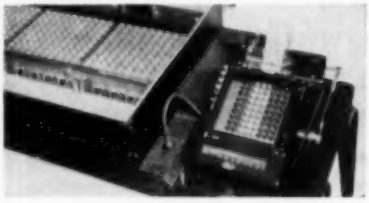
A sound recommendation for an upward revision of rates is, of course, preceded by an accurate and authoritative analysis of customers' bills.

It is possible to make such laborious compilation of customer usage data in one's own offices, but—many utilities all over the United States find that it pays to turn over the task to the Recording and Statistical Corporation.

Here's why: Our specially designed Bill Frequency Analyzer, shown here, classifies and adds in 300 registers—in one step.



It provides data in one-half the usual time—and at one-half the usual cost. It's one of many reasons why we have been providing gas, electric and water utilities with usage analyses for years.

Send for FREE booklet

Get the facts about this accurate and economical way of analyzing your customers' usage data by writing for a copy of "The One-Step Method."

Recording and Statistical Corporation

100 Sixth Ave. New York 13, N. Y.

(Continued from page 64)

An oil-immersed selenium rectifier made by Brance-Krachy Co., Box 1724, Houston, Tex., and intended for cathodic protection applications is the subject of a leaflet being distributed by the company.

A differential pressure transformer made by Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa., is described and illustrated in Bul. 2250 of that organization. The device measures pressure or flow differentials and has a range of 5 to 25 psi. with loading pressure in the 0-60 psi. range, 2.5 to 12.5 with 0-30 psi. loading pressure, or 1 to 5 psi. with 3-15 psi. loading. Static pressures may be up to 300 psig. The loading pressure may serve to actuate an automatic control system or may be used to indicate or record the differential measured, either directly or in terms of rate of flow.

(Continued on page 68)

How to join *more* bell and spigot cast iron water mains *per hour* ...at less cost

ELIMINATE USE OF HIGH PRICED LEAD

Haymanite **JOINTING COMPOUND**

Each lb. of Haymanite equals 4 lbs. of lead . . . reduces time, fuel and handling . . . eliminates caulking and large bell holes . . . simple to apply . . . self-sealing when broken.

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Company .....

Address .....

City ..... Zone ... State ..... (As-6

(*Continued from page 66*)

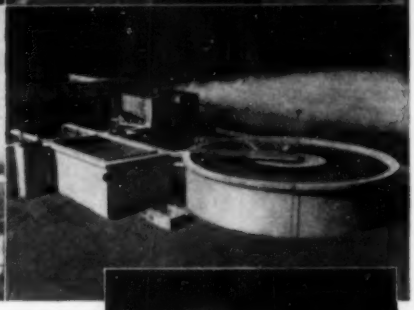
A vertical centrifugal pump, the Hydro-Line, designed for applications where either net postive suction head or installation space is limited, is the subject of a bulletin, No. B-592, issued by Peerless Pump Div., Food Machinery and Chemical Corp., Los Angeles 31, Calif. The pump is rated to handle up to 5,000 gpm.

Two stage, double suction centrifugal pumps made by Worthington Pump & Machinery Corp., Harrison, N.J., are described and their design features ilustrated in a folder, W-318-B21, which has just been published.

A metal channel insert for concrete construction, into which special spring nuts can be placed freely for bolting exterior fittings or supports, is described and illustrated in a four-page folder entitled "Unistrut Concrete Insert." The bulletin, No. CI-2, is available from Unistrut Products Co., 1013 W. Washington Blvd., Chicago 7, Ill.

Water clarifiers and cold process softeners are described in a bulletin, WC-103, available upon request to Dept. 110, Graver Water Conditioning Co., 216 W. 14th St., New York 11, N.Y. The booklet is devoted to the Graver Reactivator.

(*Continued on page 70*)



Specify INFILCO Equipment Throughout For Municipal Water Treating Plants!

INFILCO has specialized for more than fifty years in the design and manufacture of all types of equipment for municipal water conditioning plants—softening and filter plant equipment, recarbonators, chemical feeders and proportioners, gauges, hydraulic controls, etc. By providing a *complete range* of water conditioning equipment, Infilco offers the user the important advantage of *undivided responsibility!*

A complete laboratory and a staff of competent engineers are available for making recommendations and reports to the consulting engineer or his client. It is, of course, intended that this service shall cooperate with the work of your engineers.

The map at the right graphically illustrates the large, fast-growing number of municipal water conditioning plants from coast-to-coast, using INFILCO Equipment. Consult your telephone Red Book. Call in our nearest field engineer or write today for Bulletin No. 60-C.

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NON-FADING GLASS COLOR STANDARDS

Hellige Glass Color Standards are safely mounted in unbreakable plastic frames. They are more convenient and economical. They never fade or change, THEY NEVER FAIL.

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WRITE FOR BULLETIN No. 602

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INCORPORATED
3718 NORTHERN BLVD. LONG ISLAND CITY 1, N.Y.
HEADQUARTERS FOR COLORIMETRIC APPARATUS

(Continued from page 68)

Vibratory feeders, conveyors and related products of Syntron Co., 428 Lexington, Homer City, Pa., are the subject of a new bulletin available on request.

"Facts for Business Policy" is the title of a four-page folder describing the services of Arthur D. Little, Inc., consulting firm of 30 Memorial Drive, Cambridge 42, Mass.

A folder on the "Contractors Model" Blue Brute portable air compressor is available from the Construction Equipment Sales Div., Worthington Pump and Machinery Corp., Holyoke, Mass., as Bul. H-850-B71.

Selenium rectifiers previously produced by Syntron Co., 428 Lexington Ave., Homer City, Pa., for use in their own products are now available as separate units. A four-page folder describes the advantages of the dry plate units, which include instantaneous action, light weight, small size, ability to withstand high overloads for limited periods and trouble-free operation requiring no maintenance and assuring practically unlimited life. A new high vacuum vaporization process deposits the selenium film uniformly over the duraluminum plates, making possible the manufacture of such plates in exceptionally large sizes.

Oil seals, their functions and applications are described and illustrated in a 16-page booklet on the "Johns-Manville Clipper Seal." The seal has a one-piece, nonmetallic moulded body and a garter spring. A section on the use and installation of split seals is included. Copies of the bulletin are available from the company at 22 East 40th St., New York 16, N.Y.

IN LARGE-DIAMETER WATER LINES . . .

for **lower** first cost
lower operating cost
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and **higher** flow capacity

STEEL WATER PIPE---LINED AND COATED WITH KOPPERS BITUMASTIC 70-B ENAMEL

STEEL water pipe lines, protected inside and out by a durable coating of Koppers Bitumastic® 70-B Enamel, offer you greater savings from every angle than other types of large-diameter water line installations.

Inside the pipe, the spun lining of Koppers Bitumastic 70-B Enamel prevents tuberculation and rust. It's unnecessary to compensate for possible corrosion losses by specifying oversized diameters or additional wall thickness. The glass-smooth lining maintains a high coefficient of flow both initially and after decades of service. The resulting reduction in pumping costs is substantial.

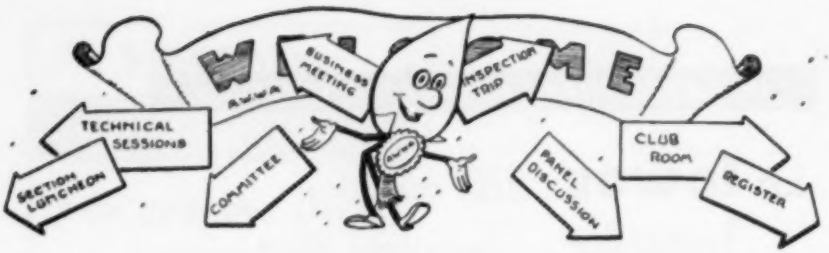
On the pipe exterior, Bitumastic 70-B Enamel prevents pitting and leakage due to soil corrosion . . . keeps maintenance and replacement costs low.

Steel pipe itself offers you other important savings. Fewer joints are required, since steel pipe can be furnished in longer lengths. And the purchase price of Bitumastic-coated steel pipe is low, too.

Give your community the most for its tax dollars by specifying steel water pipe lined and coated with Koppers Bitumastic 70-B Enamel.

KOPPERS BITUMASTIC ENAMELS

KOPPERS COMPANY, INC., Tar Products Division, Dept. 605T, Pittsburgh 19, Pa.



Section Meeting Reports

Illinois Section: The fortieth Annual Convention of the Illinois Section was held at the La Salle Hotel April 12, 13 and 14, 1950. This is the first convention that the Illinois Section has had in two years, the 1949 meeting having been eliminated in deference to the holding of the national conference at Chicago last year.

The total registration was 284, and although this was somewhat less than the total registration at the last meeting in 1948, all participating felt that the meeting was a real success. Included in the active members in attendance were representatives from 46 cities throughout the state. One reason for the somewhat lower registration was the fact that only 21 ladies were registered, as compared to 55 at the 1948 meeting; there were, however, 45 ladies at the annual banquet.

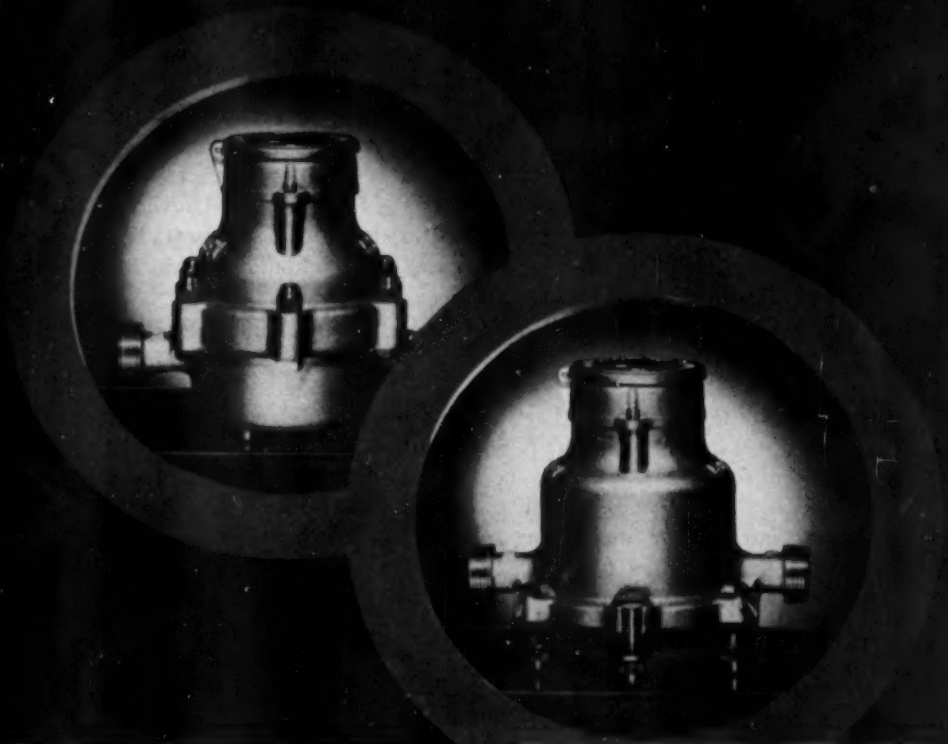
The program for the convention was carefully prepared by W. R. Gelston, the newly elected chairman of the section, and the successful acceptance of the program was evidenced by the fact that the panel discussions scheduled for Thursday morning and afternoon both had to be cut off before all of those present could discuss some questions as fully as they wished.

Thursday morning's program featured a discussion of methods of repairing and overhauling various types of meters by Dan Gannon, of the Pittsburgh Equitable Meter Division, and Henry De Pagter, of the Badger Meter Co. Considerable discussion was evoked from the floor, and it is obvious that this is a subject that can well be continued at future meetings.

Many good papers were presented, particularly one on the subject of "Fluoridation" by Jerome C. Zufelt of Sheboygan, Wis. One of the highlights was a paper on the subject of "Atomic Wastes and Water Quality" given by W. A. Rodger of the Chemical Engineering Division, Argonne National Laboratory of Chicago, who discussed the amount of radioactivity that can be expected in an open water supply as a result of an atomic explosion and the dissipation of this radioactivity within a certain time limit (*see* p. 533, this issue).

This was the first time in a good many years that the Illinois Section attempted a three-day meeting, with registration starting Wednesday morn-

(*Continued on page 74*)



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Many experienced water works officials, those men who know, standardize on

HERSEY WATER METERS

for back of every Hersey Meter stands more than 60 years of experience in design, materials and workmanship and nothing has yet been found to replace real experience.

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(*Continued from page 72*)

ing and the program sessions starting Wednesday afternoon. The program continued all day Thursday and the convention was adjourned on noon Friday. It was the feeling of the Board of Trustees that this gave more opportunity for presentation of papers and the holding of discussions than the usual two-day meeting.

At the annual banquet on Thursday night the section was treated to a very interesting and inspiring talk by W. Victor Weir, President-Elect of the national association. After the banquet those present were entertained with some very fine music presented by the Northwestern University Men's Glee Club. Before the banquet and after the entertainment, the section used the clubroom type of entertainment for a cocktail hour, which was well received by all present.

CARL N. BROWN
Secretary-Treasurer

Montana Section: The twenty-fifth Annual Meeting of the Montana Section was held in Missoula April 21 and 22, 1950. All gatherings were held in the Florence Hotel, and the total registration for the meeting was 156, including members, their wives and guests. Dr. A. E. Berry of Toronto attended the meeting as A.W.W.A. national representative and also presented a formal paper entitled "Problems in Canadian Water Works Administration."

The first of the other guest speakers who contributed to the success of the program was L. F. Warrick, U. S. Public Health Service, Washington, D. C., who discussed "Aspects of Water Pollution Control as It Affects Public Water Supplies." W. Blankmeyer, Montana Power Co., Butte, Mont., presented a paper on "Electronic Pipe Locating." During the course of his presentation, he gave actual demonstrations and showed slides of his equipment in operation. L. A. MacDonald, Northern Pacific Railway Co., Missoula, Mont., presented a paper entitled "Good Lawn Management," and E. S. Booth, of the Board of Railroad Commissioners and Public Service Commissioners, Helena, discussed "Montana Rate and Service Regulations of Water Utilities."

The morning of the opening day was reserved for the usual business meetings. The afternoon was devoted to a round table discussion, conducted by M. E. Henderson of Bozeman, Mont., on "Local Operating Problems and Procedures in Montana Communities." The afternoon of the first day was concluded by a trip through the Bonner Sawmill, operated by the Anaconda Copper Mining Co., followed by a buffet supper held at the Florence Hotel.

Saturday, April 22—the second day of the convention—was devoted to the presentation of the formal papers. The meeting was concluded by a dinner-dance Saturday evening at the hotel.

(*Continued on page 76*)

10,000 FEET MORE

of the modern main
that shortens the job
and lengthens the service

IT'S K&M "Century" ASBESTOS-CEMENT PIPE

The light weight of this strong K&M Asbestos-Cement Pipe cuts shipping and haulage costs sharply; permits of more economical laying equipment; saves many dollars' worth of time. Even when a radius requires as much as 5° deflection per pipe length, it is easily swung with the "Century" Simplex Flexible Couplings regularly used. This feature, in conjunction with lightness, speeds up any alignment needed before backfill.

Yet all of that merely begins the economies now winning increasing favor for K&M Pipe. This advanced pipe defies electrolysis and is highly resistant to soil corrosion. It doesn't know tuberculation effects; therefore, inside diameter, flow capacity and calculated pumping costs hold constant.

Traffic stresses, earth settlement and chemical attack are all minimized by K&M Asbestos-Cement Pipe—the main that the years don't weaken! As a final economy this pipe is recoverable for re-laying in its original pressure class. You can see why the savings made and the service assured always do credit to those responsible for K&M "Century" Pipe installations. Write us for full data.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

Nature made Asbestos . . .
Keasbey & Mattison has made it serve mankind since 1873

(Continued from page 74)

As this meeting was the section's twenty-fifth, special recognition was given to the 25-year members by presenting them with a gold pin in token of their continuous affiliation. The members so honored were: H. B. Foote, Helena; John Hall, Fort Shaw; Wade Plummer, Butte; J. R. Cortese, Livingston; F. E. Brandis, Missoula; H. M. Johnson, Anaconda; Eugene Carroll, Butte; and Fred Quinell, Bozeman.

It was considered by all that the 25th Annual Convention was an outstanding success and the members are looking forward to the 26th Annual Meeting to be held in Helena in 1951.

HARVEY W. TAYLOR
Secretary-Treasurer

Kansas Section: The Joint Meeting of the Kansas Section with the Kansas Sewage Works Assn. was expanded this year to include two sewage works operators forums which were held on the afternoon of opening day, April 19th. These panels opened the meeting, and afterwards an informal social evening was enjoyed by those in attendance. Over 90 persons registered the first afternoon.

Thursday morning, April 20th, with Alar B. Mawdsley, Chairman, presiding, the meeting was begun at the Salina Room of the Lamer Hotel. A. W. Rumsey, Vice Chairman, presided during part of the sessions to relieve the Chairman, who had recently been ill, but is now, to everybody's gratification, on the road to recovery.

Mayor Lloyd W. Price extended a welcome to Salina and offered all city facilities to those attending the meeting. A.W.W.A. President-Elect W. Victor Weir was scheduled on the program but he was unable to be present until Friday, at which time he discussed the progress in the water works industry. President A. H. Niles, of the Federation of Sewage Works Associations, brought greetings from the F.S.W.A. and gave an interesting review of the expanded activities of the federation. E. J. Allison, city manager of Salina, gave an interesting discussion of the Salina water system and the plans for the new softening plant which is to be built in the near future.

One of the highlights of the entire program pertaining to cities and fire protection was given by E. N. Harsha, chief engineer of the Kansas Inspection Bureau, Topeka. His discussion of water departments and classification of public fire protection was a detailed review of the classification methods used to arrive at the fire rates of various localities. John G. Stutz, executive director of the League of Kansas Municipalities, gave an interesting and informative talk on salaries and water works personnel. This discussion was supplemented by a series of tables showing salaries paid for various classifications in a number of Kansas cities.

(Continued on page 78)

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The meter used by thousands of municipalities in the U. S.

WATER METERS

"Watch Dog" models . . . made in standard capacities from 20 g.p.m. up: frost-proof and split case in household sizes. Disc, turbine, or compound type.

SURE TO MEET YOUR SPECIFICATIONS FOR ACCURACY, LOW MAINTENANCE, LONG LIFE.

Before you invest in water meters, get acquainted with the design and performance advantages which make Worthington-Gamon Watch Dog Water Meters first choice of so many municipalities and private water companies in the United States.

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The afternoon session was presided over by Robert H. Hess of Wichita. Major C. Hagar, national director from the section, reported on the proceedings of the A.W.W.A. Board during the past year. A similar report was made by E. F. Miltner, his opposite number in F.S.W.A.

Observations on the water works rate structure were made by F. A. Russell, councilman of Lawrence. He showed graphically that materials and labor have increased a great deal more than water rates, and he reminded cities that have not analyzed their rates and their policies of deferred maintenance that they will now find themselves needing to spend a great amount of money to return their plants to good condition within the next few years.

"Pure Water—Our Search for It" was the subject of the discussion by Dwight F. Metzler, chief engineer of the Kansas State Board of Health. This discussion covered potable water and the pollution of our streams by erosion, mineral contamination and sewage and organic contamination. D. B. Kissinger, superintendent of sewage treatment at Topeka, spoke on the "Effect of Industrial Wastes on Sewage Treatment" at Topeka.

Thursday evening was devoted to individual social visiting. On Friday morning Roy Binder presided, and Paul R. Shanahan, representative in the Kansas Legislature, discussed "Needed Legislation for Pollution Abatement in Kansas." In the course of his discussion he spoke of the equitable distribution of sewage treatment cost which is now financed by *ad valorem* taxation. It is the opinion that the most equitable financing of such operation and maintenance of sewer systems is on a utility basis, under which the customers of the system are charged for the amount and type of sewage they contribute. He concedes that it will be necessary for the city needing financial relief to institute an educational program so that the legislature will be informed of these needs and the practicability of such a program.

"The Value of Clean Waters to Kansas Fishermen" was discussed by Harry F. Lutz of the Forestry, Fish and Game Commission, Pratt. He also showed a motion picture entitled "Clean Waters" which was very applicable to his discussion.

A. W. Rumsey presided over a Water Works Potpourri Forum. E. S. Jungmann, Jungmann Bros, Topeka, discussed the various methods of keeping water wells operating. H. H. Hanlen, city clerk at Winfield, discussed bill collecting methods. James D. Barker, water superintendent at Winfield, described his homemade tools and methods used in cleaning water mains in Winfield. A check of his time and footage showed what an excellent job someone with determination and a little ingenuity can accomplish. Public relations were discussed by W. Willis, acting superintendent of water and light at Iola.

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At noon a luncheon was held for the entire group after which the business meetings were held for the A.W.W.A. and K.S.W.A. groups. Lester T. Hagadorn presided at the afternoon meeting. "The Kansas River Basin Water Pollution Investigation" was explained by Paul D. Haney, senior sanitary engineer with the U. S. Public Health Service at Cincinnati, Ohio, who supervised this survey. This river survey is one of the first and most complete pollution investigations on a river basin that has been made.

The technical meeting was closed with a Round Table entitled "It's Different Here." Bob Millar, manager of the Wichita Water Co., and George Pate, water superintendent at Nickerson, acted as operators. H. H. Kansteiner, manager of the Water Works Dept. at Leavenworth, V. E. Hougland of Russell, Harley Culler of Eureka, and a number of others took part in the lively discussions. Everyone participated, and an interesting and informative section closed the meeting.

The Annual Banquet was held on Friday evening with Alar B. Mawdsley presiding. The principal speaker was J. G. Baldivieso, Bolivian Consul for the Midwest and an instructor at Kansas Wesleyan University, who held the interest of his audience in an enlightening discussion of inter-American affairs.

MAJOR C. HAGAR
For the Secretary-Treasurer

Nebraska Section: The annual meeting of the Nebraska Section was held jointly with the Spring Meeting of the Utilities Section of the Nebraska League of Municipalities at the Cornhusker Hotel in Lincoln, April 13 and 14. This practice of joint meetings has been followed for the past three years—since the section was organized—and has been found to be very satisfactory.

The meeting was called to order on April 13 by Ray Chase, Chairman of the Utilities Section of the League. The group was welcomed to the City by Acting Mayor Thomas R. Pansing of Lincoln.

The general subject of stream pollution was well covered in a two-part presentation by L. E. Ordelheide of the Missouri State Board of Health, who covered the national aspects of the situation, and R. M. Babcock, sanitary engineer of the Nebraska State Board of Health, who presented local aspects of the situation in Nebraska.

C. J. Hutchinson of the Link Radio Co. presented a paper on "Two-Way Radio Use in the Municipal Electric and Water Utilities." While few Nebraska municipalities are ready for this kind of expenditure, there are several such systems in use—some entirely independent of the police systems—and these have been found very beneficial in the larger communities both in improving service and, through that, in improving public re-

(Continued on page 82)

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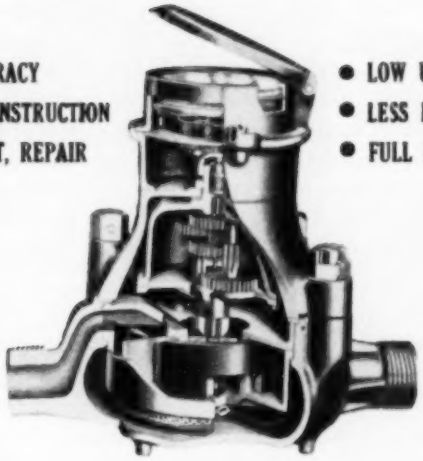

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(Continued from page 80)

lations. The expense in two or three larger municipalities has been found to have been offset by decreased service costs within a relatively short time.

At noon the group enjoyed a buffet luncheon in the ball room of the hotel.

After the group was again called to order, this time by Vern Livingston, Chairman of the section, Lee M. Nelson, superintendent of Rochester, Minn. Municipal Utilities, presented a fine paper on "Realistic Public Relations." "Water Meter Department Practices" were discussed by W. H. Dominick of the Wichita, Kan., Meter Supply & Repair Co. A paper on "Procedure of Acquisition of a Gas Utility" was then presented by Thomas M. Davies, attorney of Lincoln and a member of the Nebraska State Legislature. Despite its title, the subject of the paper is of vital concern to many eastern Nebraska water superintendents, whose pumping costs are directly affected by the cost of power, as a result of recent efforts by producers and distributors to increase the price of gas.

Mayor L. D. Torrens of Wahoo discussed "What a Mayor Expects of The Municipal Utilities." That evening the annual banquet was held in the hotel.

On Friday, April 14, Niles H. Barnard, chairman of the Dept. of Mechanical Engineering of the University of Nebraska, gave his report on the Annual Utilities Conference held on the University campus in February. This Utilities Conference has been jointly sponsored by the Department of Engineering and Architecture of the University, Nebraska Section of the A.W.W.A., and the Utilities Section of the Municipal League.

"Personnel and Public Relations in Municipal Government" was discussed by Winfield Best, personnel director of the American Municipal Association. E. H. Curtiss, attorney at Plainview, Nebraska, presented a discussion of "Financing Municipal Extensions and Improvements Under Existing Nebraska Laws." A final business meeting was then held to discuss the section's affairs.

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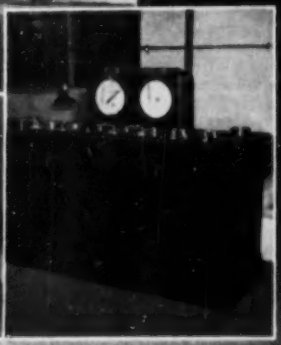

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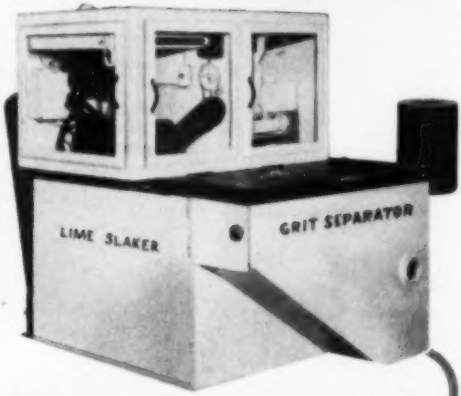

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Hersey Mfg. Co.
James Jones Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
Worthington-Gamon Meter Co.

Meter Reading and Record Books:
Badger Meter Mfg. Co.

Meter Testers:
Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Domestic:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
A. P. Smith Mfg. Co.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Meters, Filtration Plant, Pumping Station, Transmission Line:
Builders-Providence, Inc.
Infilco, Inc.
Simplex Valve & Meter Co.
R. W. Sparling

Meters, Industrial, Commercial:
Badger Meter Mfg. Co.
Buffalo Meter Co.
Builders-Providence, Inc.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Simplex Valve & Meter Co.
A. P. Smith Mfg. Co.
R. W. Sparling
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Mixing Equipment:
Chain Belt Co.
Infilco, Inc.
Walker Process Equipment, Inc.

Ozonation Equipment:
Welsbach Corp., Ozone Processes Div.

Pipe, Asbestos-Cement:
Johns-Manville Corp.
Keasbey & Mattison Co.

Pipe, Brass:
American Brass Co.

Pipe, Cast Iron (and Fittings):
American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe, Cement Lined:
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe Coatings and Linings:
The Barrett Div.
Cast Iron Pipe Research Assn.
Centriline Corp.
Dearborn Chemical Co.
Koppers Co., Inc.
Warren Foundry & Pipe Corp.

Pipe, Concrete:
American Pipe & Construction Co.
Lock Joint Pipe Co.

Pipe, Copper:
American Brass Co.

Pipe Cutting Machines:
Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Pipe Jointing Materials: see **Jointing Materials**

Pipe Locators:
Jos. G. Pollard Co., Inc.

Pipe, Plastic:
Carter Products Corp.

Pipe, Steel:
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.

Pipelines, Submerged:
Boyce Co., Inc.

Plugs, Removable:
James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.
Warren Foundry & Pipe Corp.

Potentiometers:
Hellige, Inc.

Pressure Regulators:
Ross Valve Mfg. Co.

Pumps, Boiler Feed:
DeLaval Steam Turbine Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Centrifugal:
American Well Works
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Chemical Feed:
Infilco, Inc.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.

Pumps, Deep Well:
American Well Works
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

Pumps, Diaphragm:
Dorr Co.
Proportioneers, Inc.

Pumps, Hydrant:
Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:
Ross Valve Mfg. Co.

Pumps, Sewage:
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Sump:
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Turbine:
DeLaval Steam Turbine Co.
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

THE FIRST MECHANICAL JOINT TAPPING SLEEVE AND VALVE

ELIMINATES { MELTING, POURING, CAULKING

A new all Mechanical Joint Tapping Sleeve and Valve, installed quickly and easily even by untrained workmen. The only installation equipment necessary is a 10" ratchet wrench and a standard open end wrench.

There are no joints to pour or caulk.

Installation can be made in wet trenches in any kind of weather.

The "Stuffing Box" type joints require no cutting or scarfing of rubber gaskets on job.

Assemble Sleeve on main—attach the Valve, the installation is complete, ready for tapping and the joints are permanently bottle-tight.

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GATE VALVES
CHECK VALVES
FIRE HYDRANTS
INSERTING VALVES
TAPPING SLEEVES AND VALVES
WATER SERVICE BRASS GOODS

THE A. P. SMITH MFG. CO.
ESTABLISHED 1896
EAST ORANGE, NEW JERSEY

FLOOR STANDS
INDICATOR POSTS
TAPPING MACHINES
INSERTING MACHINES
PIPE CUTTING MACHINES
CORPORATION TAPPING MACHINES

Recorders, Gas Density, CO_2, NH_3, SO_2, etc.:
Permutit Co.
Wallace & Tiernan Co., Inc.

Recording Instruments:
Builders-Providence, Inc.
Infilco, Inc.
R. W. Sparling
Wallace & Tiernan Co., Inc.

Reservoirs, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages; see Gages

Sleeves; see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
Permutit Co.

Soda Ash:
Solvay Sales Div.

Sodium Hexametaphosphate:
Calgon, Inc.

Softeners:
Dearborn Chemical Co.
Dorr Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon, Inc.
Infilco, Inc.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Storage Tanks; see Tanks

Strainers, Suction:
M. Greenberg's Sons
R. D. Wood Co.

Surface Wash Equipment:
Permutit Co.
Stuart Corp.

Swimming Pool Sterilization:
Everson Mfg. Corp.
Omega Machine Co. (Div., Builders Iron Fdry.)
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Tanks, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Tapping Machines:
Hays Mfg. Co.
A. P. Smith Mfg. Co.

Taste and Odor Removal:
Industrial Chemical Sales Div.
Infilco, Inc.
Proportioneers, Inc.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Telemeters, Level, Pump Control, Rate of Flow, Gate Position, etc.:
Builders-Providence, Inc.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Turbines, Steam:
DeLaval Steam Turbine Co.

Turbines, Water:
DeLaval Steam Turbine Co.

Valve Boxes:
Central Foundry Co.
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valve Inserting Machines:
A. P. Smith Mfg. Co.

Valves, Altitude:
Ross Valve Mfg. Co., Inc.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
James B. Clow & Sons
M. Greenberg's Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Valves, Float:
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Dresser Mfg. Div.
James Jones Co.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Large Diameter:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Regulating:
Ross Valve Mfg. Co.

Valves, Swing Check:
James B. Clow & Sons
M. Greenberg's Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Waterproofing
Dearborn Chemical Co.
Inertol Co., Inc.

Water Softening Plants; see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Dearborn Chemical Co.
Dorr Co.
Everson Mfg. Corp.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Infilco, Inc.
Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Stuart Corp.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

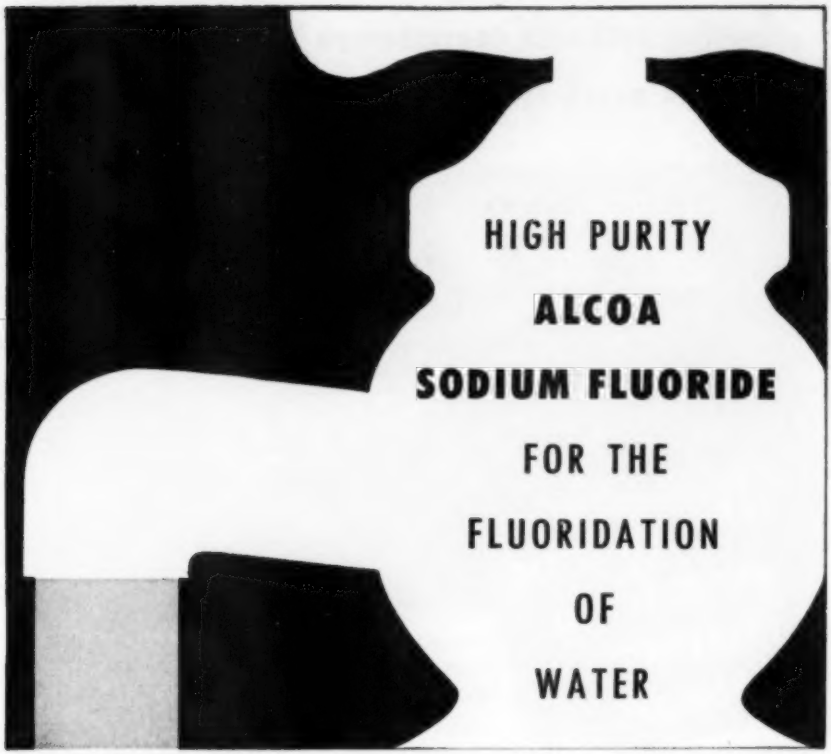
Well Acidizing:
Dowell Incorporated

Well Drilling Contractors:
Layne & Bowler, Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite; see Ion Exchange Materials

A complete Buyers' Guide to all water works products and services offered by A.W.W.A. Associate Members appears in the 1948 Membership Directory.



ALCOA Sodium Fluoride, like all other Alcoa Chemicals, has a uniform high degree of purity. It may be used with confidence for the fluoridation of water supplies. ALCOA Sodium Fluoride flows freely . . . is easy to handle . . . dissolves at a uniform rate. Besides that, ALCOA is a *dependable* source of supply.

If your community is fluoridating its water supply—or is considering doing so—let us discuss with you the properties of ALCOA Sodium Fluoride that make it particularly suitable for your use. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 624 Gulf Bldg., Pittsburgh 19, Pennsylvania.

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Another ROCKWELL CONTRIBUTION

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PITTSBURGH EQUITABLE *Water Meters*

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YOUR UNRESTRICTED *Choice* OF METER TYPES

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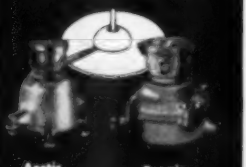

Arctic — Tropic

This* ELECTRONICALLY CONTROLLED *TESTING PLANT in our water meter factory is the only one of its kind. It will handle up to 240 meters at a time on four test lines. In it, your orders for any of the domestic sizes of Pittsburgh Equitable meters (Arctic, Tropic or Empire) will be precisely tested for accuracy to your specifications. The control panels can be quickly adjusted to match the conditions that will be actually found in your system. For example, where specified, meters going into warm climates can be tested for accuracy and response at water temperatures of 100° F. or higher.

By duplicating your actual operating conditions on the test stand we assure accurate measurement from the word "go". Now, more than ever before, good basic designs, plus careful workmanship and exacting tests make your choice of any Pittsburgh Equitable meter an outstanding value.

Pittsburgh Equitable Meter Division

ROCKWELL MANUFACTURING COMPANY

Pittsburgh 8, Pa.

Atlanta Boston Chicago Columbus Houston Kansas City Los Angeles New York Pittsburgh San Francisco Seattle Tulsa

View of Miami, Fla. waterfront showing section of Bayfront Park, Biscayne Boulevard, and Business Section. Photo—City of Miami News Bureau.

4 Dorrco Hydro-Treators

for new water softening plant!

Dorrco Hydro-Treators—four 69′ dia. units—were the choice for the latest addition to Miami's expanding water system. Designed by the Planning Division of Miami's Department of Water & Sewers, the new softening plant will be located near Coral Gables.

The four Dorrco Hydro-Treators will soften an average flow of 40 MGD of well water. Maximum flow will be 52 MGD . . . minimum 10 MGD. Chemicals added will be lime and sodium silicate. Carbonation will follow pre-treatment. Temporarily a maximum of 17 MGD will be delivered to mains, after passing redissolving and safeguarding facilities.

The selection of Dorrco Hydro-Treators for Miami was based upon operating efficiency and economy. Data from both operating installations and field tests proved the ability of the Hydro-Treator to produce continuously effluents of exceptionally low turbidity. From the standpoint of economy, both low first cost and low operating costs were factors. Low power requirements and dense underflow were two of the important savings in operating expense.

If you're interested in high-rate units it will pay you to look at the facts.

Cutaway view of the Dorrco Hydro-Treator.

DORRCO

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RESEARCH ENGINEERING EQUIPMENT

LEADITE

Trade Mark Registered U.S. Pat. Office

Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains MUST BE GOOD,—MUST BE DEPENDABLE,—and that is just why so many Engineers, Water Works Men and Contractors aim to PLAY ABSOLUTELY SAFE, by specifying and using LEADITE.

Time has proven that LEADITE not only makes a tight durable joint,—but that it improves with age.

The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%

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No Caulking